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Deferred Flood Damage Again The possibility of damage done by the severe floods of last March showing itself at this late date was pointed out editorially in these columns on June 28 as a lesson drawn from the collapse of a bridge at Watervliet, N. Y. That the warning was well worth while has since been demonstrated by two disasters attributed to the same cause. At Dayton three men were injured and several score narrowly escaped in the collapse of a roundhouse, while a pier of a railroad bridge near Lafayette, Ind., went into the river only ten minutes before a train was due. It is not recorded in either case what inspection was made of the structures after the flood, but the warning is sufficiently clear that those having charge of structures subjected to the ravages of the high water of last spring should take no chances as to their condition.

The Governor Makes Good All honor to him who keeps his word and, therefore, it would seem appropriate to pay tribute to the Governor of New York—for has he not carried out the pledge of his party platform to appoint a "practical railroad man" to the Public Service Commission of the Second District? The appointee, or nominee, as he is till confirmation, is indeed a practical railroad man, having risen through the positions of brakeman and fireman to that of locomotive engineer, which he now occupies. Some few people might construe practical railroad experience, when considering the qualifications necessary for service on a utilities commission, to mean such training as would fit one to pass on bond issues, to determine the adequacy of rates, to decide difficult terminal cases and to weigh the merits of petitions for certificates of convenience and necessity. But, then, some people have peculiar ideas and do not appreciate the political capital created by catering to particular classes! Possibly the Governor feels that he "has made good." Very few others do.

The Kuhn Collapse Holding companies are so uncommon in the waterworks field that the ramifications of financing often accompanying the absorption of many small properties by a large one are seldom brought home to the waterworks officials as forcibly as they are to those in fields where consolidations are almost the rule rather than the exception. How the scheme often works, however, was plainly shown by the collapse of the Kuhn interests at Pittsburgh, where two national banks, a private banking firm and a holding company chiefly interested in waterworks properties, all came to grief through the difficulties of one of the banks. The central organization of the group was the private banking firm of J. S. & W. S. Kuhn, Inc. One of the brothers was head of the First-Second National Bank, the other dominated the American Waterworks & Guarantee Company, and both as a firm advertised widely and sold the securities of forty utilities. To this close community of interest was due whatever success had attended the firm's transactions. The holding company has been successful, earning from properties as diverse from one another as irrigation is from coal mining about $1,750,000 last year. That success, however, was predicated upon its ability to command large resources, and this it was able to do because of the banking connections of the Kuhns. Robbed of this affiliation, it tottered into receivership. The indications are that the financial backers of the American Waterworks & Guarantee Company discounted the future in their promotion schemes, hoping that growth would enable the properties to pull along the heavy burdens placed upon them. It appears that collateral highly prized by the bank officials did not appear to be worth much to the government investigators or to other Pittsburgh bankers. This would indicate pyramiding, an evil to which holding companies are peculiarly susceptible. If such is the case, the failure can readily be understood, for the crumbling of one stone in a financial structure of that character is sufficient in times of financial stress to cause the whole to collapse.

State Water Scheme Legal The obstacles to the development of the Wharton tract by the State of New Jersey for the supply of water to communities in the southern part of the state seem now to be entirely removed. The tract, having an area of 110,000 acres and an estimated yield of 400,000,000 gal. per day, was originally purchased by private parties with a view to supplying water to Philadelphia therefrom. This use was prevented, however, by the passage of laws forbidding the transportation of water out of the state. The State Water Supply Commission arranged to purchase the tract and proposed to issue therefor $1,000,000 in bonds, but since the state constitution forbids a debt exceeding $100,000 except in time of war or threatened invasion, a friendly suit was brought by the attorney-general to test the legality of the law. The Court of Chancery now supports the Water Supply Commission on the ground that the commission is a corporation distinct from the state.

International Road Congress The general impression carried away by those who attended the Third International Road Congress in London last month appears to be that a distinct advance was made over the results obtained at the two former meetings in Paris and Brussels. This, of course, was to have been expected, for experience is an excellent teacher and during the three years which have elapsed since the Brussels meeting highway engineers throughout the world have not been idle. It is true, of course, that the last word on the art of road-building will not be said for many years. Practice in the various countries is far from uniform and under present conditions any conclusions reached by an international body will naturally be confined to matters which are already universally accepted as good practice. Although the conclusions of the congress, printed in detail in the Current News Section of this issue, developed nothing essentially novel, they are still of interest, for they indicate the trend of thought among highway engineers and public officials. One of the most regrettable features of the congress, from the American viewpoint, was that the United States was not officially represented. It is true that 25 or 30 men from the United States made the trip to London and through the courtesy of their hosts were enabled to participate in the proceedings, but the embarrassing position which they were forced to occupy can be appreciated when it is known that 39 countries were represented at the congress—all, except the United States, by official delegates. Congress, in its wisdom, provided at its last session that "hereafter the Executive shall not extend or accept any invitation to participate in any international congress, conference or like event without having specific authority of law to do so." The next international road congress is to be held in Munich in 1916. It is earnestly hoped that by that time the obstacles which prevent highway engineers of the United States from meeting those of the other world powers on an equal footing will have been removed.

Regulation of Cherry Creek A flood-prevention report of no small proportions and worth was recently presented to the Denver Board of Public Works with recommendations for a bond issue of $1,000,000 with which to buy land and construct a regulating reservoir. Its presentation caused no excitement and little or no comment from the local press—so soon are flood damages forgotten and public interest lost! What matters it to them even if the walled channel will carry but one-half of the known discharge! The white shining sands in the dry bed of the creek give such a false sense of security that the engineer's cold-blooded hydrographs, discharge curves and run-off percentages make no appeal. No less than thirteen unusual floods have occurred in this stream since the first on record in 1864, which drowned nineteen citizens and damaged property to the extent of several thousands of dollars. Even before this time the Indians, knowing the character of the stream, warned the settlers that if they persisted in building in the Cherry Creek Valley their homes would be swept away. The recent report is replete with accounts of these old disasters and contains a full description of the damage done last July, which early exaggerated reports placed at $500,000 for the city and $1,500,000 for the corporations. These sums have dwindled until the statement is made in the report that probably all monetary damage to city structures would be covered by $50,000 and to private property by from $250,000 to $500,000. Little damage was suffered by the public-utility companies. There were two distinct storms, one in Denver and another covering only a small portion of the watershed. The latter resembled the rains which caused the Dayton disaster, in that the storm passed downstream at approximately the same rate that the water in the channel did. As noted in the abstract on page 81 the most feasible plan reported by the commission involves the construction of a $500,000 regulating reservoir near the city limits. The silt problem is disposed of by the proposed use of the sand and gravel for building purposes; the investment feature, by the fact that much of the land would be available for parks on which no permanent structures need be erected or by farming until parking becomes desirable. Already some of the recommendations of the commission have been carried out, all, however, on the assumption that the channel width will remain at 80 ft. Four flat-slab concrete bridges with center piers have replaced bridges with hanging plate girders, some of which a commission of the Chamber of Commerce characterized as diversion dams. Contrary to general belief, there is nothing unusual or phenomenal about the Cherry Creek floods, and Denver should be sure that the factor of safety relating to the waterway under all new bridges has been carefully considered. Data are now available, and whether the particular plan recommended is carried out or not, engineers should not rest till adequate measures are put into effect. A large monetary loss is almost certain if existing conditions are not improved, further encroachments checked and a definite plan of regulation carried out.

Creating Great Precedents

The structures on the New York Connecting Railway described on page 79 include three of very unusual interest—an arch span of unprecedented dimensions and capacity, the substructure for the span, involving extremely difficult foundations, and the high retaining walls and fill for a remarkable embankment or causeway. The steel superstructure of the 1000-ft. arch span has dimensions placing it almost in a class by itself, so far are they beyond those of other similar structures, and the problems of design, fabrication, and erection will accordingly demand treatment of more or less originality, supplemented by the best resources in shop and field.

An arch span, above all others, requires the most stable foundations, which ordinarily have been carried to rock at moderate depths. Where this could not be accomplished the site has generally been considered unsuitable for this type of structure; but in this case, despite the extremely heavy loads, the arch will be used even though one end must be carried on foundations sunk through boulders, quicksand and water through a great depth to bearing on what is expected to be a very irregular rock surface. One or two massive pier footings have heretofore been adopted for arch abutments, but in the Hell Gate Bridge each of the abutment foundations will consist of five separate compound sections, two of which, in the planes of the arch trusses, and designed to take a large proportion of the arch thrust, will be rectangular in plan, consisting of several separately constructed units bonded together. Beneath these footings there will be three longitudinal rows of five separate cylindrical footings each, designed to carry vertical loads from the massive pier.

It is proposed to build these footings with reinforced-concrete caissons cast above ground and sunk as far as possible by loading and by open dredging through the interior wells. It is known that they will encounter a deep bed of boulders, beyond which there is a still deeper stratum of sand, with indications of rock from 70 to 140 ft. below the surface. Ground-water level is very near the surface and the close proximity to the river and the character of the soil make it certain that an unlimited quantity of water will be encountered at all stages. Provision will be made for converting the open footings to pneumatic caissons and continuing the work under air pressure if necessary, and it is hoped that it will prove possible to sink them, open or closed, to a depth of 140 ft., or more if necessary. The limits of human endurance under excessive pressure and the enormous frictional resistance that will be encountered are fully recognized by the contractors and engineers, who, nevertheless, expect to overcome the difficulties. Their progress and methods will be watched with great interest, and if they are successful under conditions as difficult as seem possible the achievement will be of the highest order.

The treatment of earth pressures and retaining walls is acknowledged to be among the most difficult and disputed of engineering problems. It is, therefore, usual to design them conservatively. In this case the steel viaducts, adopted on part of the line, are replaced for a considerable length on one section by a solid viaduct or causeway, consisting of an earth embankment of a maximum height of about 60 ft. and a width of 60 ft., carrying four freight and express tracks and inclosed between thin parallel concrete walls with one vertical and one slightly battered face. It is believed that by compacting the selected earthfill in thin convex layers there will be given to it a stability so great that the horizontal thrust on the side walls will be reduced almost to elimination and that the function of the walls will approach that of mere facing. The walls will, however, be connected at intervals by horizontal rods engaging reinforcing and distributing steel members embedded in the concrete and calculated to care for any balanced pressures which may be developed against the inner faces of the walls. Obviously this construction effects an enormous reduction in masonry and will be a most important precedent if the earth there can be made to attain and permanently maintain an approximately independent stability. It is no novelty to compact or even to curve or incline the layers of earthfill, but the application of the principle on such a large scale and the reliance placed on the stability of the fill in a most important structure are probably without precedent and show splendid engineering courage.

Transportation and City Planning

The relation between transportation and city planning has been more and more emphasized as the manifold ramifications of the latter subject have become manifest. It was dimly appreciated from the start that if people were to be moved to the country facilities must be provided to transport them quickly and cheaply from their new homes to their employment. But the many other points where transportation and city planning touch were not apparent at the start. How intimate the relations are, however, is well shown by the paper by Mr. Milo R. Maltbie abstracted on page 65. Some of the points are especially worthy of attention.

His remarks on the economics of subways are especially important in view of the demand that arises from time to time in nearly every large community for this form of rapid transit. He emphasizes the fact that in order to offset the burden of large fixed charges there must be a dense traffic, and that in turn means congestion of population. But congestion, whether in business or in residential (if tenement neighborhoods can be so called) districts, is opposed to the fundamental idea on which proper city planning is based. In practically all American cities, save New York, long subways are not economically advisable. After the reasonable car capacity of the streets has been exceeded the most practical form of development is the construction of a terminal subway or elevated line over which all or part of the cars can be routed through the business district. The terminal subway in Boston, for example, has been a great factor in relieving street congestion.

The importance of straight and direct streets for the car routes is also pointed out by Mr. Maltbie and may well be borne in mind by those who delight in laying out "magic-maze" towns, which while commendable and beautiful could very well reduce to hopeless inefficiency a street railway corporation that attempted to operate over the sinuous streets.

The crying need of more efficient handling of foodstuffs in cities may be solved, in Mr. Maltbie's judgment, by using the tracks of the street railway system in conjunction with proper interchange facilities between it and the interurban lines. The idea is not a new one and the wonder is that the scheme has not been more largely developed. The fairly large express systems in Cleveland and Syracuse and the recent development in Boston indicate that there are no fundamental difficulties. It is evident, however, that both the cities and the companies have not, in general, addressed themselves seriously to the problem. That the degree of control Mr. Maltbie believes necessary will be generally accepted is doubtful, but certainly there must be a different relationship than now exists between municipality and company if there is to be progress along these lines. There must be a better spirit of co-operation and a keener realization that the interests of the two are mutual. With such a basis established, greater progress can be expected.

Chicago Garbage Situation

Again the Chicago garbage situation arises to be solved just as the city council is ready to adjourn for the summer vacation. For two years the matter has been under consideration and is no nearer solution than at first. Meanwhile the end of the contract, which expires Sept. 1, with the Chicago Reduction Company gets nearer and nearer and the city is face to face with the alternative of renewing that contract or, as Mayor Harrison says, of dumping the garbage into clay holes.

Several months ago bids were asked on a specification that was but little more explicit than the cablegram from an Oriental water department to a New York filter company asking for a quotation on "a filter plant and five miles of pipe." No disposal companies bid on these indefinite specifications. Then the city engineer's office was asked to prepare specifications for a plant located on a site to be furnished by the city on the main sanitary canal. Recently it was found that the city had picked a piece of ground so tied up in litigation that only the courts could decide its ownership. In consequence these bids had to be abandoned.

Not long ago Mayor Harrison, who sees no other way out of the difficulty than to renew the present contract, paid a visit to the present plant and is reported to have found things "clean as an old maid's kitchen," the floors washed and scraped and the processes evolving practically no odor. A few days later members of the Woman's City Club on an unheralded inspection trip were not so favorably impressed. To anyone who has visited a plant fixed up for official inspection and knows it in its regular every-day slouchiness both stories are perfectly plausible.

Gathering garbage and reducing it to an innocuous state is certainly not angel's work, but the fact that the plant can be made clean and respectable for inspection should serve as a hint to the officials to insert in any agreement extending the contract that the place shall be kept in that condition by rigid city inspection. With a renewed contract as a temporary expedient no time should be lost in placing the whole matter in the hands of an expert for solution in a permanent way, as has been urged by the Engineering Record on more than one occasion. The attitude of those handling the matter, which constitutes one of the reasons why outside talent is needed, was well illustrated when a representative of this journal on a quest for information was immediately surrounded by a typical crowd of political appointees and told that "no engineers are employed; only a good practical man with common sense is needed."

Handling garbage in Chicago was studied during the last year by the efficiency division of the Civil Service Commission, but the report related only to collection, although when the investigation was started it was the general impression that the whole situation would be reported on. How soon Chicago will take this problem firmly in hand and solve it satisfactorily seems uncertain. The jarring into life of some of the council committees that fear they will be stripped of some of their powers by the new state public-utility law indicates that the time is favorable for the appointment of a committee that will get results. The Engineering Record hopes that a live garbage committee will be appointed, that it will catch some of the enthusiasm of the local transportation committee, which proposes to reduce the insanitary crowding of elevated cars by increasing the loop capacity from 700 to 1100 cars per hour, and that the example of the railway-terminal committee in employing an engineering adviser of recognized standing will be emulated.

Proposed Wisconsin Water-Power Law

A water-power bill of a decidedly "advanced" character was introduced in the Wisconsin Legislature on July 3. While it is so radical in its provisions that it should stand but little chance of passage, it is the culmination of so much water-power-legislation "tinkering," and covers matters of so great interest to hydraulic engineers and power companies, that a review of the measure is well worth while.

In considering water-power legislation in Wisconsin it is well to note that previous to 1911 permits or franchises had been granted only by special act of the legislature in each individual case, there being no general law under which a water-power plant could be constructed. Following the general discussion of "conservation" which swept through the country a few years ago, various members of the legislature convinced themselves that the riparian owners of water powers within the state had no rights that the legislature was bound to respect. Hence in 1911 they passed a water-power bill, which practically confiscated all the water powers both developed and undeveloped. This matter was brought before the Wisconsin Supreme Court and was declared unconstitutional. The following paragraphs from the decision are of interest:

"The right of the riparian owner to use the water of the river on his own land within his boundary determined by ordinary high water mark, for the purpose of creating power or, as the act in question puts it, 'developing energy,' returning the water again to the stream, is unquestionably a private right appurtenant to the riparian land."

"These premises support the conclusion that the act in question attempts to deprive the owners of improved riparian land and of the resulting water power and owners of unimproved riparian land with its appurtenant water-power privileges and advantages, of property without due process of law; that it attempts to authorize the taking of private property for private purposes; and that it attempts to take property without just compensation. The act in question, in the particulars mentioned, is inconsistent with the paramount commands of the state and of the Federal Constitution applicable to the same facts and conditions. Hence, we cannot recognize it as law."

It will be noted from the above that the Supreme Court has declared, in no uncertain way, that the water powers of the state are the property of the riparian owners. Not content with this decision, various members of the legislature have been endeavoring to find some way in which they could practically appropriate these water powers for the benefit of the state and still avoid conflict with the decision. The bill offered on July 3 is the result of this effort.

Briefly, this bill attempts to force any riparian owner who wishes to develop a water power and who must apply to the state for a permit so to do to sign away to the state his rights in said power for the privilege of developing or utilizing it. He is to be allowed "the value of the power site exclusive of any rights to water power or to the use of water power or its availability in connection with the use of water power," and after the expiration of thirty years, which is the limit of the franchise, the state, if it has the constitutional power, or any municipality "may acquire all of the property of the corporation used and useful under the franchise by paying therefor as determined by the [railroad] commission at the time of taking, the cost of reproduction in the then existing condition of all dams, works, buildings or other structures or equipment used or useful under the franchise and by paying in addition thereto the value of the power site as determined by the commission before the granting of the franchise," not including, of course, any water-power value.

It is, of course, evident that any water-power company which purchases a power site must pay its actual value for water-power purposes—or at least so much of the same as the owner may demand. If condemnation is attempted, any jury must hold under the Supreme Court decision that the water-power privilege is an appurtenance of the land and it must give a value based on this decision. Under the proposed law, however, no such value could be recognized by the railroad commission, and no allowance would be made by such commission of such value; hence, any amount paid for water-power privileges, or any benefit to be derived from such privileges, must be realized before the expiration of the franchise.

Furthermore, the limitations of the territory in which the power can be sold are under the control of the railroad commission, as well as the rates to be charged. While it is probable that any rate commission acting under such a law would take these various conditions into account in the making of rates, and permit the charging of such rates as would admit of a fair return under the conditions of the franchise, yet it is evident that the state cannot assure such rates and that any failure to secure them would result in a loss to the water-power company from which there would be no escape.

The bill provides that if a water-power plant is to be constructed for the purpose of operating a paper mill or other manufacturing plant, the power company must be organized as a separate corporation, must sell its power to others besides the plant which it was incorporated to serve, and at the end of the franchise period might be taken over by the state or a municipality, leaving the manufacturing establishment entirely without power, and possibly valueless.

This bill as drawn is based on the idea that the water powers of the state are of very great value; that thirty years' use is ample compensation for their development, and that the profit accumulated within that time is sufficient to compensate the owners for all the rights to which they are legally entitled. If there was an active demand for power from water-power installations at the cost of the development of power by steam, water powers in some parts of the state would undoubtedly be very valuable, although this is not true when the larger cities of the state are considered. The main difficulty in the way of securing such compensation for water-power energy lies in the fact that a power can be developed in general only when a market is already established—that is, for communities where steam is already used. When an attempt is made to sell current at such points the user takes the position that his fixed charges are already incurred and that if he is to take power at all it must be furnished to him at a reduction below his station charges. This means in general that the current must be sold at one-half, or less, of the actual cost of steam power, fixed charges and operating expenses being considered. In many cases this will leave no margin whatever for the water-power plant, and in other cases one that is comparatively small.

The Engineering Record knows of no cases in Wisconsin where water-power properties for public service have been very profitable. The LaCrosse Water Power Company, with an investment of $2,500,000, went into the hands of a receiver and was sold at a price that netted the bondholders about 8 per cent on their holdings. The Kilbourn plant, representing an actual investment of more than $2,000,000, has been in operation about five years and has paid one dividend amounting to $15,000. No water-power plant in general service in Wisconsin, so far as known, has yet been able to pay materially more than interest, depreciation and maintenance, although few for such service have been in use for more than a few years, and some of them ultimately will probably prove to be reasonably profitable.

In some cases the flood contingencies have caused very great expense from which some of them can never recover. The greatest profit which can be realized from water-power plants in Wisconsin would accrue from combining them either with other service corporations or with manufacturing establishments where the value of the power used would be fully equal to the cost of steam. This the proposed law absolutely prevents.

As a business proposition there must be an opportunity to realize returns on any investment commensurate with the hazard involved, and the hazard in the case of any water-power property is necessarily large.

The bill if enacted will be fatal to any further development of water power in Wisconsin. Under it the investor must take all of the risks of unforeseen contingencies, of securing a market, of regulation of rates, of being compelled to make greater investments than he desires, of ultimate confiscation of at least his water-power rights—and even then with very little hope of any reasonable financial return. No engineer of intelligence could ever advise an investor either to build a plant or to buy securities of a water-power plant under such a law.

Antelope Valley Siphon, Los Angeles Aqueduct

Four-Mile Concrete and Steel Pipe Riveted under Bonus System

By William W. Hurlbut, Chief Draftsman, Los Angeles Aqueduct

There are constructed on the Los Angeles aqueduct twenty-one siphons, having a total length of 12.43 miles; thirteen of these are riveted steel pipes, with an aggregate length of 9.39 miles, the remaining eight being reinforced-concrete pipe with a total length of 2.14 miles. The steel siphons vary in diameter from 7 ft. 6 in. to 11 ft., while the concrete pipes are all 10 ft. in diameter. Reinforced-concrete pipe was used on the construction of siphons whose maximum head did not exceed from 75 to 80 ft.

The Antelope Valley siphon crosses the gentle slopes of the Antelope Valley 188 miles south of the intake in Owens Valley and 50 miles north of the Fernando Valley, the end of the aqueduct. This siphon, while not the largest on the aqueduct in point of head, has the greatest tonnage, being 80 tons heavier than the Jawbone siphon, with a head of 850 ft., and is by far the longest, being 4.11 miles in length, with a maximum head of 200 ft.

Three Divisions of Pipe

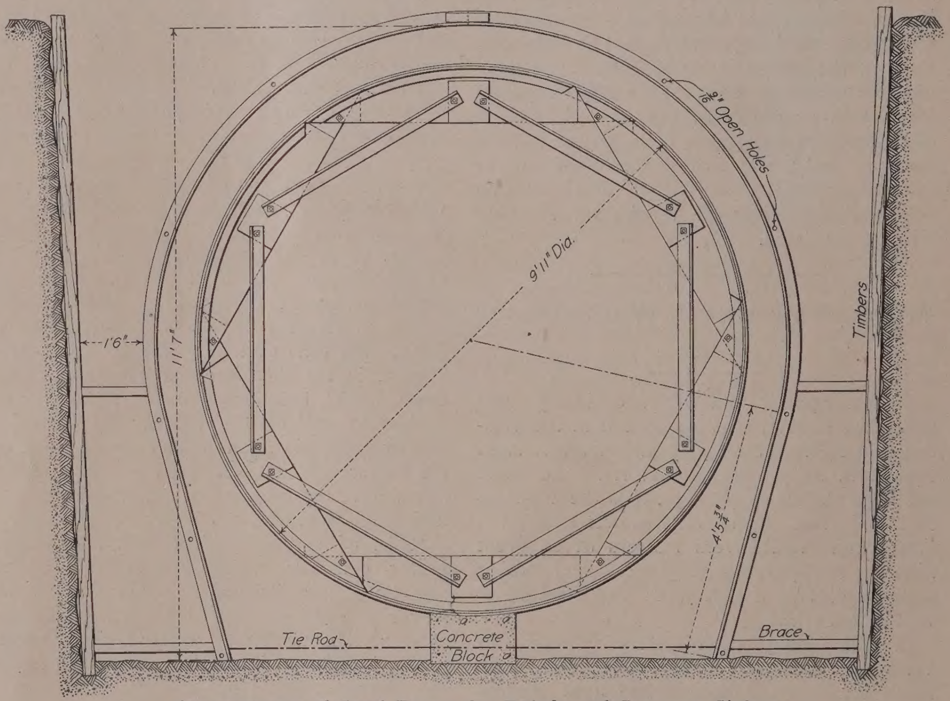
The pipe is divided into three parts. The north end is of reinforced concrete, 2750 ft. in length; the middle portion is of riveted steel plate, extending for a distance of 15,597 ft., and the south end is of reinforced concrete, 3447 ft. long.

The pipe has an inside diameter of 10 ft. throughout its entire length, the concrete portions being carried down to 80 ft. of head on each end, at which point the transition to the steel pipe takes place. The hydraulic gradient for the concrete pipe is 0.0008 and for the steel pipe, 0.0015. The difference in elevation between the north and south ends is a drop of 29.38 ft.

The steel pipe consists of 7249 ft. of ¼-in., 3698 ft. of 5/16-in. and 4650 ft. of ⅜-in. steel plate.

The construction of the 6197 ft. of concrete pipe was commenced in July, 1911, and completed in November of the same year. Excavation for the concrete portions was made with a Model 40 Marion steam shovel, the material being desert soil, which was easily excavated. A quarry was established to furnish crushed rock near both the north and south ends of the siphon, the haul varying from 4 to 6 miles; sand and gravel were also hauled about the same distance. The teaming was done by force account, using twelve-mule teams with one trailer, at a cost of 12 cents per ton-mile.

The pipe is built entirely of Fairmont tufa cement, which is 50 per cent by volume of straight Portland cement, manufactured by the city's mill at Monolith, Cal., and 50 per cent tufa. A double saving is accomplished by using this cement, first, in the reduced price of the cement itself, and, second, in the railroad and wagon haul on about one-half of the amount of straight cement between Monolith and Fairmont. By this regrind process about 75 cents per barrel has been saved in transportation charges alone. Tufa cement is slower in getting its initial hardness than straight cement, but by the end of twenty-eight days it is fully as hard and by the end of six weeks it has a greater strength than straight cement, and is steadily gaining strength, as the two-year breaks show at the present time in excess of 600 lb. The average wagon haul from the Fairmont tufa mill was 22 miles, at a cost of 12 cents per ton-mile and averaging 1 ton to the animal, using twelve-mule teams.



Arrangement of Steel Forms for Reinforced-Concrete Siphon

Hauling Steel Plates from Mojave to the Siphon

Construction Quantities

The construction quantities are as follows: 1.24 cu. yd. of concrete per lineal foot; longitudinal reinforcement, seventeen ¾-in. rods 36 ft. 11 in. long, lapped 3 ft. 2 in. and spaced about 2 ft. center to center; transverse reinforcing, spaced 4 in. center to center. Up to 15 ft. of head ⅜-in. rods 35 ft. 4 in. long are used; for 30 ft. of head, ½-in. rods, 35 ft. 10 in. long; for 45 ft. of head ⅝-in. rods, 36 ft. 5 in. long, and up to 80 ft. of head ¾-in. rods, 36 ft. 11 in. long.

The hydraulic properties are as follows: Hydraulic slope, 0.0008; area, 78.54 sq. ft.; wetted perimeter, 31.416 ft.; hydraulic radius, 2.50; velocity, 5.88 ft. per second; capacity, 463 sec.-ft.; *n*, 0.014; *C*, in Chezy formula, 124.

Forms

The form ribs were spaced 4 ft. apart. The six-segment inside form was supported on concrete blocks, 1 ft. high, 1 ft. thick and 1½ ft. long, laid under each form in the bottom of the trench, the upper surface being cast to the radius of the pipe. The segments of the inside forms are all interchangeable and are bolted together. The panels are covered with 16-gage metal and are 2 x 4 ft.

The outside forms are in two pieces, bolted together at the top, and are made of 3 x 3 x 5/16-in. T-bars. They are blocked against timbers at the sides of the trench, and the panels, which are pinned through open holes, hold them longitudinally. One hundred and fifty feet of forms were all that were required on the work. Reinforcing rods were bent to the proper radius in the field.

Concreting

A Ransome mixer was used, mounted on high trucks especially rigged to allow the placing of the concrete by gravity flow. The concrete was poured very wet, using a mix of 1:2:4. An average of about 50 ft. a day was made; the concrete was stripped of the forms on the third or fourth day; at this time the trench was backfilled, the top of the pipe being even with or below the surface of the ground. The inside of the pipe was trowel plastered about ½ in. thick, using a mixture of 1 to 2 or 3 of sand and cement.

The cost analysis for both ends of this pipe is given in Table 1 for direct field charges.

An average of 1.48 cu. yd. of concrete per lineal foot on the north end and 1.30 cu. yd. on the south end was used. The cost does not include overhead or auxiliary charges, which amount to about 20 per cent.

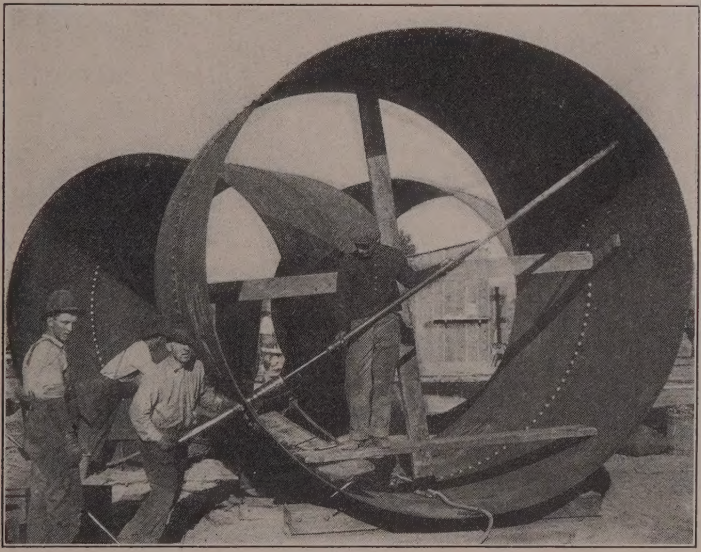
The steel, or middle portion of the Antelope Valley siphon, was furnished by the Riter-

Conley Manufacturing Company, rolled and punched at a cost of $1.50 per hundredweight f.o.b. factory at Leedsdale, Pa., or $2.30 per hundredweight laid down at Mojave, Cal., the distributing point for this work. The plate was shipped nested in order to obtain the minimum rate for carload lots. The plate is of the lap-joint type, the inside rings being 10 ft. in diameter.

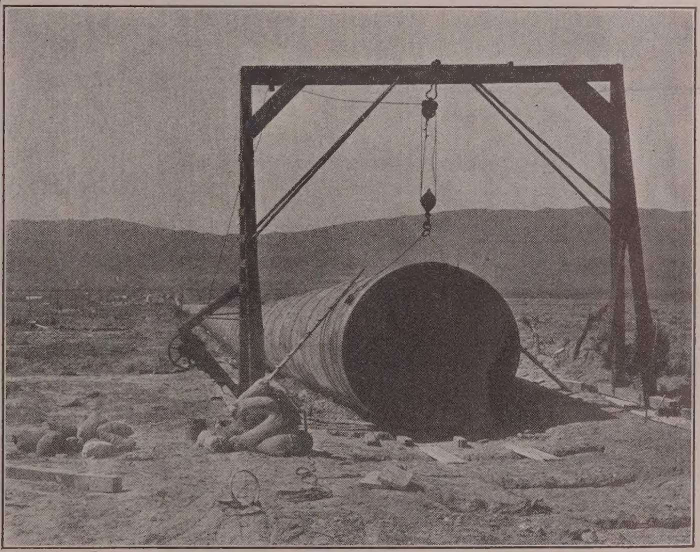
Table 1—Cost Analysis for Concrete Pipe

Description	North end, 2750 ft., cost per ft.	South end, 3447 ft., cost per ft.
Steam shovel excavation	$0.59	$0.94
Excavation, moving shovel	.05	..
Lining—		
Rock and gravel	1.85	3.68
Cement	6.25	5.80
Mixing and placing	.96	.91
Setting forms	.55	.62
Steel and placing	4.00	4.30
Plastering	.70	.26
Superintendence	.17	.26
Backfilling	.33	.39
Engineering	.03	.04
Average cost per foot of completed section	$15.48	$17.20

The thickness of steel was designed for an ultimate strength of 60,000 lb. per square inch on the gross section, with a factor of 4, and a working stress of 15,000 lb. per square inch on the gross section, and without additional allowance for deterioration.



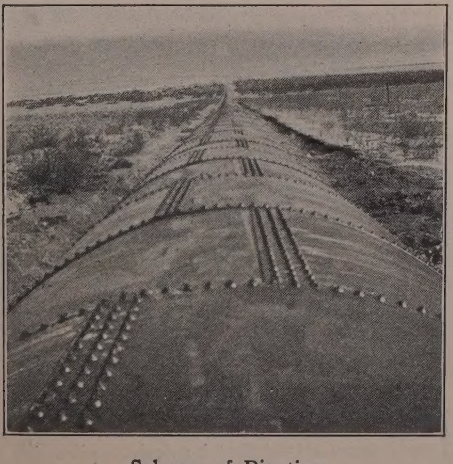
Riveting Double Ring Section, ⅜-Inch Plate



Method of Erecting the Pipe in the Trench

The shearing strength of rivets is 38,000 lb., the efficiency of joints ranging from 72 to 80 per cent.

The roundabout seams are all single-riveted. One-quarter inch plate up to 100 ft. of head was used with double-riveted longitudinal joints, the remainder of the plates being of triple-riveted longitudinal joint construction.



Scheme of Riveting

Table 2 gives lengths and weights and safe heads of each thickness of metal.

Table 2—Steel-Plate Data

Thickness	Safe head, feet	Length, feet	Weight, pounds
¼-in. double-riveted	100	2690.006	938,810
¼-in. triple-riveted	144	4559.332	1,609,440
5/16-in.	180	3697.542	1,626,920
⅜-in.	210	4650,000	2,648,970
Total		15,596,880	6,648,970

Where changes in thickness of plate occurred sections were tapered so that in no case was the inside diameter less than 10 ft. There are no horizontal angles in the pipe, and only six vertical angles, the maximum angle being 1 deg. 6 min. and the minimum 6 min.

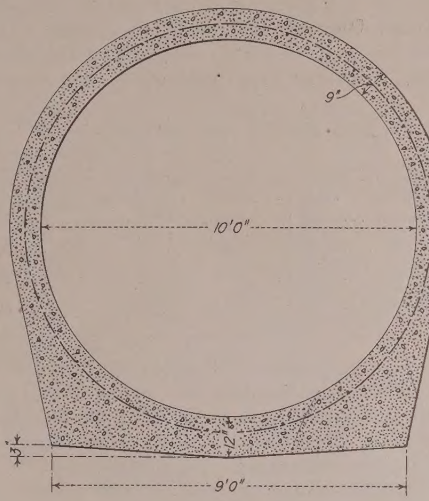
C in Chezy's formula was used as 90; the hydraulic gradient is 0.0015; the velocity, 5.51 ft. per second, with a capacity of 433 sec.-ft.

Hauling Material with Mules

Mojave is the division headquarters and the nearest railroad point to this work, being 35 miles distant. For the hauling of the pipe from this point three stations were established 10 miles apart; twelve-mule teams were used for this hauling, the average load being 12.9 tons, or a little more than 1 ton to the animal. A team made 20 miles a day, loading at Mojave, arriving at the 10-mile station at noon; at the 20-mile station at night of the first day; at the 30-mile station at noon of the second day; leaving there and discharging the load at the siphon the afternoon of the second day; then returning to the 30-mile station the same night; returning the following day to the 10-mile station; and at noon of the fourth day reloading at Mojave, thus making the round trip in three and one-half days. The cost for this long haul averaged 12 cents per ton mile, which is half of the lowest bids by contract for the same class of work received by the city.

Excavation for this pipe was done with slips and the pipe backfilled about one-third of its circumference in the sand.

The plate was all field-riveted. All plates are 72 in. in width. The ¼ and 5/16-in. plates were riveted in four-ring sections, or 24 ft. in length, and the ⅜-in. plates in two ring sections, or 12 ft. in length. These sections were then rolled into the trench and picked up with an A-frame derrick and entered and bolted. Due to the intense heat during the day all the riveting in the trench was done at night, the 12 and 24-ft. sections being fabricated and bolted in the trench during the day.



Section of Concrete Siphon

Erection of this siphon commenced in the middle and was worked both ways from this point. All rivets were cone-headed and of full-diameter shank; ⅝-in. rivets were used on the ¼ and 5/16-in. plate and ¾-in. rivets on the ⅜-in. plate.

Bonus System for Riveting

The riveting crews made good speed, due in part to the bonus system which was adopted on this work. Ten days constituted a bonus period, thus giving three bonus periods to each month. Bonus payments were allowed upon the basis of measurements made at the close of each ten-day period. Only men who had worked continuously through the ten-day period were entitled to a bonus, with the following exceptions: First, a man injured or taken sick during the periods from conditions due directly to siphon construction; second, employees transferred to other parts of the work by the superintendent in charge; third, the interruption of work due to a shortage of material or supplies, failure of power or other causes beyond the control of the men. In such cases the bonus was allowed in proportion to the shifts worked by him during the period.

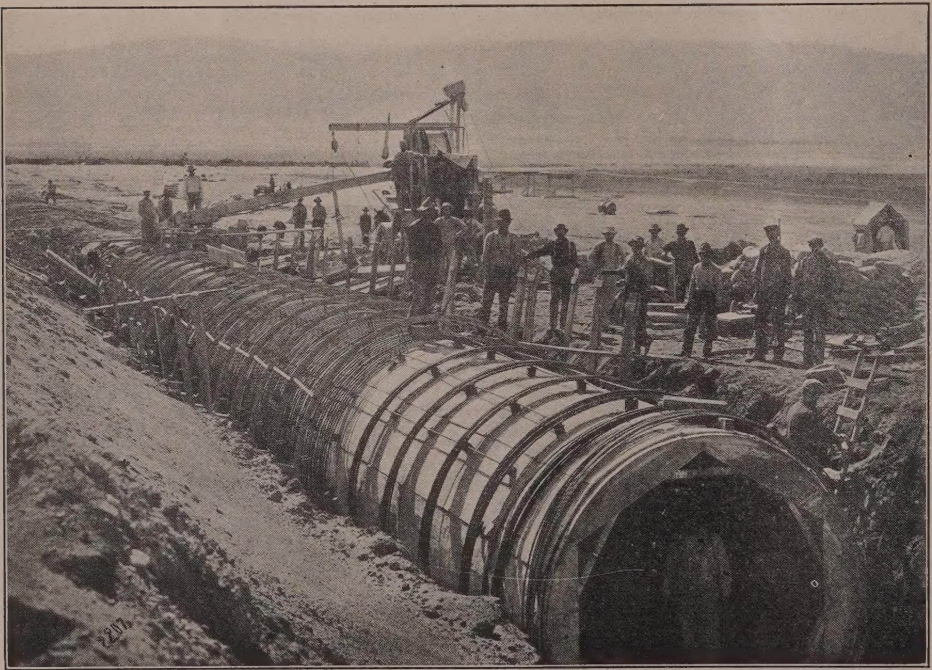
Table 3 gives the schedule for siphon work for a typical riveting crew of four men.

The world's record for field-driven rivets was made on the erection of this pipe, one man driving 1650 ⅝-in. rivets in one eight-hour shift.

The compressor plant was located in the center, or 1½ miles from each end of the pipe. Due to the fact that the city's electric transmission line did not extend south of Mojave, it was necessary to provide other than electric energy for power to drive the compressor plant. The plant consisted of four 40-hp Aurora gas engines, all belted to a line shaft, the line shaft in turn being belted directly to an Ingersoll-Rand air compressor. Two lines of 4-in. O. D. casing delivered air at a pressure of 110 lb.

Table 3—Bonus Rate for Riveting Crew

Mechanic. Each per shift	Size of rivet, in.	Wages, per day	Base rate, per shift	Crew bonus, cents per rivet	Per cent of bonus per man per shift
Riveter ...	⅝ ¾	$3.50	500 400	1½ 1¾	30
Heater	⅝ ¾	3.00	500 400	1½ 1¾	30
Bucker	⅝ ¾	2.75	500 400	1½ 1¾	20
Sticker ...	⅝ ¾	2.50	500 400	1½ 1¾	20



Forms, Reinforcement and Mixing Plant for Concrete Pipe

The plant was very successful and gave efficient service. Ingersoll-Rand and Boyer air hammers were used. The pipe was calked inside and out with a blunt-nose calking tool.

Two 24-in. blow-off valves are located at the lowest point in the valley; these valves are half way up on the pipe. There is also a 4-in. drain pipe located in the bottom of the pipe. The pressure on the valves is 86.8 lb. per square inch, the discharge being 441 sec.-ft., with a velocity of 70 ft. per second. The diameter of the handwheel is 24 in., the gear rating being 3 to 1, requiring a force of 15 lb. on the handwheel, which is threaded to ¼-in. pitch, 50 per cent. being allowed for friction.

TAR-PAINT COATING

Lead paints and pipe preservatives of a number of varieties were tried, but it was found that in order to use them it was necessary to chip off the rust scales, as they did not penetrate through to the metal, so a coal-tar paint was used. This tar, which is the residue from crude oil in the manufacture of water gas, is the same as coal tar, except that lampblack heated to incandescency is used instead of coal to decompose the steam. The tar paint was heated, then cut with naphtha, and applied with brushes. The paint penetrated through any rust scales formed on the pipe and adhered directly to the surface of the metal under the rust scales. This paint is not only cheap but a very good preservative of the metal, the cost being 8 cents per gallon. One gallon covered 400 sq. ft. The pipe is painted both inside and out with two coats.

Table 4 gives direct field charges of costs for the steel pipe.

To the cost shown in the table should be added 10 per cent for overhead charges. The average cost of driving 645,957 rivets was 2.9 cents per rivet, and the average cost per pound of erecting was 3.39 cents. The erection of steel commenced in April and was completed in September, 1912. The greatest progress was made during the month of August, when 5940 ft. were erected.

Expansion in this pipe amounted to 23 in. from 5 a. m., the coolest part of the day, until midday, the hottest part. As soon as the pipe was filled with water this movement ceased, because the temperature of the pipe is held more uniform and also the weight of water tends to prevent this movement. There are no expansion joints in this pipe.

The steel pipe at the points of transition to the concrete pipe extends 5 ft. into the concrete pipe. The pipe was filled with water up to this point, and during the cool weather mass-concrete block anchorages were built, incasing the pipe for a length of 27 ft. At a distance of 6 ft. apart, or at the center of each of the three plates, angle irons cut in four segments were riveted to the outside of the pipe. The concrete was put in to a depth of 10 ft. beneath the pipe, with a width of 15 ft. and a thickness of 1½ ft. around the pipe. Reinforcing bars are all ¾ in. in diameter, the transverse rods being spaced 4 in. apart and thirty-four longitudinal rods spaced about 2 ft. center to center and staggered.

Table 4—Field Costs for Steel Pipe

Description	Length, feet	Unit cost	Cost per cwt.
Trench excavation	15,597	$0.33	
Anchorages, proportion	15,597	.48	
Steel pipe:			
Cost rolled and punched at Mojave	15,597	9.84	$2.30
Loading and hauling.........	15,597	1.46	.34
Placing	15,597	.52	.12
Riveting	15,597	1.19	.28
Calking	15,597	.24	.06
Painting	15,597	.15	.04
Equipment	15.597	.87	.21
Superintendence	15,597	.11	.03
Engineering	15,597	.04	.01
Backfill	15,597	.19	
Bell hole, proportion	15,597	.11	
Dismantling camp, proportion	15,597	.01	
Manholes, proportion	15,597	.01	
Blow-off valves, proportion..	15,597	.03	
Total		$15.58	$3.39

The pipe has been filled with water for several months and tested out. At these points of transition only a hair crack has occurred where the steel meets the concrete; these transitions are holding the pipe and no seepage has occurred. There are 150 cu. yd. of concrete in the two transition anchorages, which cost $2,223.

This entire work was done by the Los Angeles Aqueduct Bureau by force account, under the supervision of Mr. William Mulholland, chief engineer; Mr. J. B. Lippincott, assistant chief engineer, and Mr. H. A. Van Norman, division engineer in direct charge of the work.

Governmental Responsibility for Delays on Contracts

A recent decision of the Court of Claims on damage caused to government contractors by failure of a bureau of the government to take prompt action on a question arising under an engineering contract lays down principles of such interest that the opinion of the court is here abstracted.

The case was that of John C. Rodgers & Company, contractors for the Norfolk drydock, claiming damages for being stopped for some weeks in the prosecution of their work in December, 1904, and January, 1905, to await a decision of the chief of the Bureau of Yards and Docks as to whether he should exercise an option reserved to him in the contract to omit a pile foundation under the dock.

The case was elaborately argued by Mr. George A. King, of King & King, for Rodgers & Company and by Mr. Ashford, of the Department of Justice, for the government. The decision of the court, as will be seen, holds the government liable for unreasonable delay in settling this question. The opinion of the court by Judge Howry is in part as follows:

The specifications placed the civil engineer in charge of the work with full control and direction subject to appeal to his chief; required the contractors to commence work immediately after execution of the contract and continue without interruption and complete the work within thirty-six calendar months from the date of execution of the agreement. There was a provision for annulling the agreement in case of failure to complete on time, and liquidated damages at the rate of $50 per day were provided for by way of deduction for such failure.

The structure proper and wing walls were to be founded on piles, and test piles were to be driven to constitute a portion of the permanent piles of the dock. Provision was made, however, that bearing piles might be omitted in order to reduce the cost $70,000, but there was no provision in the contract to lessen the obligation of the contractors to proceed with all necessary work to complete on time.

A few weeks before the contractors began driving the piles they were urged to make more rapid progress to the end that the dock should be completed within the time provided for by the agreement. After several conferences with the chief of the Bureau of Yards and Docks by the civil engineer and one of the plaintiffs it appeared that the chief of the bureau stated that he desired piles driven, and only after 700 had been placed were the contractors stopped by orders of the chief of the bureau, communicated to them through the civil engineer in charge of the work. These orders were accompanied with the statement from the chief of the bureau that the work should be stopped until he should decide the question of founding the work upon piles.

In a conference about the matter on or about Dec. 12, 1904, the chief of the bureau stated that he would give a decision immediately. It was not until Jan. 25, 1905, that the civil engineer in charge received a telegram from the Bureau of Yards and Docks stating that the chief of the bureau had decided to put in piles throughout the entire length of the dock.

The contention of the defendants is that there was no such breach of the contract arising out of the fact that the chief of the bureau delayed the decision as constituted a breach of the contract.

The court is of the opinion that it became the duty of the defendants to account for a part of the delay. The government's agents knew the causes which operated upon the defendants to delay the work of the contractors and to so show these causes as to enable the court to determine where the fault lay and whether the defendants either were or were not excusable. That no proof has been taken by the defendants shows that they had no explanation to offer, but on the contrary justifies the inference that the delay was the result of inattention. It is reasonably certain that but for the interference of the defendants in stopping the driving of piles the work would have proceeded and damage to the plaintiffs would have been avoided.

The court does not wish to be understood as creating a precedent in this case for other cases of department delays or as establishing a general rule of universal application. Each case of alleged delay must stand upon its own merit where contractors complain of delays or bad faith of public officers.

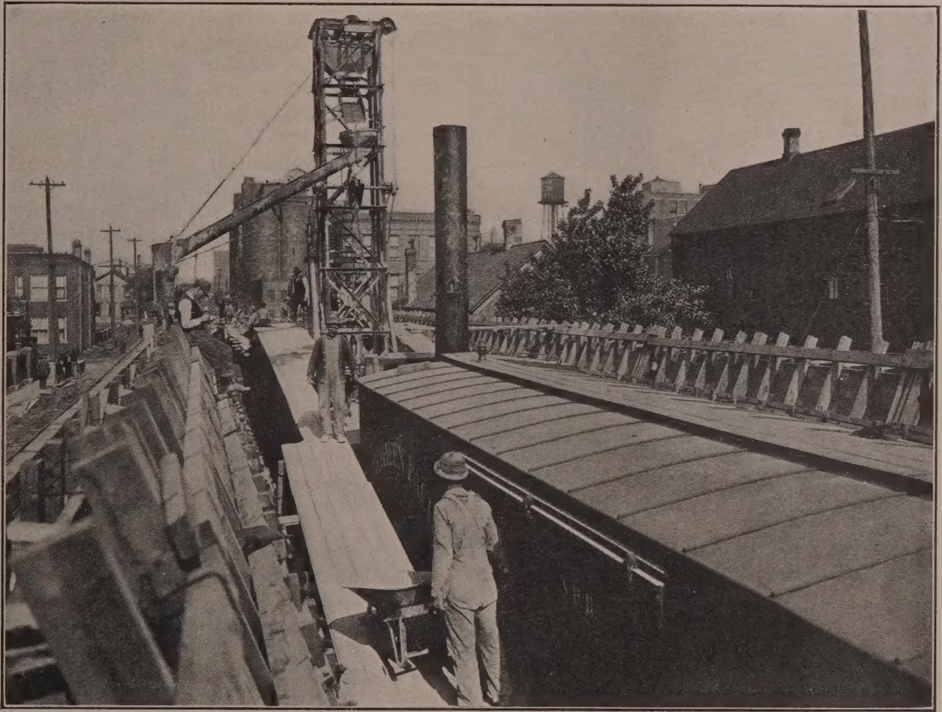
In the view we have taken of the case we are of opinion that the natural consequences of the stoppage of the work justly entitle plaintiffs to recover for the time disclosed by the findings.

Handling Cement in Bulk

By J. H. Libberton, M.E., Assoc. M. W. S. E.,
Assistant Engineer, Universal Portland
Cement Company

Within the last year considerable mention has been made of what appears to be a new method of shipping Portland cement; that is, in bulk. In reality considerable cement was transported in this condition as far back as 1886. Since many of the costs on various construction works are necessarily similar, due to labor conditions, equipment, etc., the problem of efficient handling of materials is a serious one and worthy of careful consideration when close estimates are to be made.

Radical departures from standard methods of handling materials must at first meet with opposition, regardless of merit, for well-known psychological reasons. In this case the habit of handling cement in packages thoroughly grounded by the custom of nearly half a century, must be entirely changed. When cement sold for $4 to $6 per barrel, a matter of 30 or 40 cents for the container did not seem such a large proportionate amount of the value of the contents. Nevertheless, when the idea of packing in cloth was advanced because of the lessened expense the suggestion met with instant approval and the result was the total abandonment of the wooden barrel as a container for cement.



Using Bulk Cement on Retaining Wall Construction

Since the general adoption of the cloth sack as the standard package for shipping cement there have been numerous contenders for the paper package. An analysis of this situation can lead to only one conclusion—that the cloth sack is an expensive proposition. Else why should anyone be willing to pay 10 cents per barrel for paper without expectation of a return on the investment?

The figures of one of the leading cement companies prove that, extending over a period of twelve years, the percentage of sack returns has been only 85. In other words, 15 per cent of the sacks, amounting in value to 6 cents per barrel, has been lost somewhere along the line, the sacks serving the numberless uses with which most persons are familiar, such as aprons, tool cases, shoe soles, etc. In spite of all that can be done, it seems impossible to prevent many of the various, almost criminal, methods of throwing money away.

A TIME STUDY

With the thought of investigating actual work with bulk cement, a time study was made of the various operations of a gang, using first sacked cement and afterward cement in bulk. The work under observation was that of the Chicago, Milwaukee & St. Paul Railway on its retaining-wall construction at Bloomingdale Road and Robey Street, Chicago, described in the Engineering Record of June 21, page 701.

The accompanying illustration shows plainly the arrangement of the mixing equipment utilizing a ½-yd. mixer, a vertical hoist and an open spout for discharging into the forms. The material cars and mixer were run in between the wall forms on a single track in the following order—cement car, mixer car, gravel and sand flat cars. It is plain from this layout that a time study will be identical whether using sacks or bulk except in loading the wheelbarrows with cement, dumping cement and emptying cement into the mixer.

The length of cement haul was 120 ft., and the load was two bags or 2 cu. ft. of cement. The net time of loading two bags on a wheelbarrow was 0.4 minute, while the time of filling the barrow with bulk cement was 0.9 minute, net; but this difference was largely offset by the delay occasioned in unloading sacks and picking up the empties, which brought this figure from 0.4 up to 0.7.

Since these figures do not take into account the lost time or time of transportation from the car to the mixer, the comparison of 0.7 minute for sacks as against 0.9 minute for bulk is somewhat misleading. When these other items are considered the difference between the two practically vanishes, so that the labor in handling is nearly identical, without figuring, of course, the time of the man at the mixer necessary to help unload and untie sacks and feed cement to the mixer. Taking this man's time at 42.5 cents an hour [under usual conditions a much lower rate is paid for such labor] for an eight-hour day the extra cost is $3.40, which, when figured against an output of 125 cu. yd. to the day, makes the cost per cubic yard 2.72 cents greater because of handling cement in sacks. To this we should add the average loss from unreturned sacks of 6 cents per barrel, or 7.43 cents per cubic yard of 1:2½:5 concrete in addition to the cost of counting, tying into bundles and shipping the sacks back to the mill. On the particular job under observation the counting and the bundling are first done on the job, but on account of the inaccuracy of the workmen the bundles must again be checked and inspected before being returned to the mill, which brings the cost still higher, to about 1 cent per barrel, or 1.24 cents per cubic yard of 1:2½:5 concrete. The basis for this assumption is taken from another construction job where the entire time of one man is utilized in shaking and bundling about 1600 sacks per eight-hour day, so that this figure of 1 cent per barrel and 1.24 cents per cubic yard is a very conservative estimate.

Totaling these different items: 2.72 cents, 7.43 cents, 1.24 cents = 11.39 cents.

Take, for example, the cost data of Messrs. Taylor & Thompson, in their book, "Concrete Costs," for a two-bag batch mixer with the concrete discharged into the hopper and a two-wheeled hand cart at 60 cents per cubic yard of concrete, with labor at 20 cents per hour. Calculating the labor cost at 42.5 cents per hour brings the cost up to $1.28 per cubic yard. With the improved methods of handling concrete, however, which the Chicago & Milwaukee Railway is employing, this figure is probably high, but for purposes of illustration it will be assumed to be correct. This would indicate that the saving per cubic yard of 11.39 cents against $1.28 is nearly 9 per cent of the total cost of placing the concrete—really an item worth while considering. Take, for instance, the construction of the Keokuk dam, which required over 650,000 cu. yd. of concrete. Assuming that a saving of 11.4 cents per cubic yard could have been accomplished by the use of bulk cement, the cost of this construction could have been reduced $74,100.

Non-Productive Investment

Nothing whatever has been said thus far concerning the investment necessary to carry through a large job of construction, using cement in sacks. Assume a job requiring 600 bbl. per day with a storage capacity of 1000 bbl. additional. The sacks represent an investment of $640, which, however, must be increased on account of the impossibility of returning the sacks immediately and, undoubtedly, on large construction work this figure may be doubled or tripled, making the probable investment well over $1,500. This same amount of money, if invested in equipment, would be paying dividends rather than eating up profits in interest.

With any movement like the utilization of cement in bulk rather than sacks there is bound to be a great deal of opposition at first. This is gradually being overcome, and the time must undoubtedly come when cement in bulk will be generally adopted for large construction work, particularly where central mixing plants are installed, thus making the handling of the materials most economical. There seems to be no good reason why cement should not be handled in identically the same manner as sand or gravel, and instead of providing only two large hoppers, three are equally practicable, the third, of course, to contain the cement in bulk.

The feasibility of this method of handling cement has impressed manufacturers of conveying machinery, and the suggestion at present is to handle the cement from the car in the same manner as grain or coal is manipulated, by means of a drag with steel rope and windlass carrying the cement out of the car door and into a hopper leading to a vertical elevator. Equipment of this kind could be self-contained, portable and adaptable to almost any kind of construction. It has been calculated that with such an apparatus one man could unload a car of bulk cement in at least fifteen to thirty minutes, since the same thing is now being accomplished in unloading grain from cars in about three to five minutes. With this method of handling the unloading of cement in bulk would be a very simple and economical matter. When once delivered to the hopper, there would be no rehandling or repiling, which seems to be one of the necessities in using sacked cement.

Inertia of the Contractor

So far as the writer can determine, the only reason bulk cement has not been more generally adopted is the lack of inclination on the part of the large contractors to investigate the matter thoroughly, many preferring to draw their conclusions without having seen any of the work in progress or without being willing to give the proposition the trial which it undoubtedly deserves. Those not acquainted with cement in bulk contend that conditions in the car are unbearable and that the workmen will sink in the cement up to their knees while unloading the wheelbarrows. This, however, is not true, since in transportation the continual jarring thoroughly packs the cement so that it is possible to walk around on the surface without sinking in more than ¼ to ½ in. The writer has seen several cement storehouses on construction work in which the cement from torn sacks was distributed over the floor in a layer 5 or 6 in. deep and kept fluffy by the workmen carrying cement to the mixer without stopping to clean up the floor, and this without any complaint whatever from the laborers.

In proportioning the concrete for large work the same methods would be employed as for sand or gravel, using merely a measuring box filled from a chute leading to the cement bin. On work of smaller proportions it is possible to load the cement direct into the wheelbarrow, limiting the size of the load to 2 cu. ft., which can easily be measured accurately in the average 3-ft. wheelbarrow by striking off level. The contention that by this method inaccurate proportioning is liable to occur because of the inability to count the number of sacks used has no foundation whatever, because it is just as easy to count wheelbarrows as cement sacks.

Mixing Plant Using Bulk Cement

After a thorough investigation of this subject the problem resolves itself merely into whether or not the contractor will give this matter the thorough investigation which he would any other proposed labor-saving device. Undoubtedly the day will come when bulk cement will generally be recognized, and until that time it would seem that the first to take advantage of this proposition will be the greatest gainers, because at the present time there is a decided saving with even primitive equipment. When the time arrives that bulk cement is recognized and provided for the contractor who is familiar with the handling of this material will still have the advantage of longer experience.

The Columbus Sewage Works, comprising settling tanks and sprinkling filters, will be remodeled if the recommendations of Mr. C. B. Hoover, chemist in charge, are carried out as outlined in the report of the Division of Sewage Disposal for 1912. Mr. Hoover advocates that the settling tanks be converted into the two-story type to reduce nozzle clogging troubles and to make possible better sludge disposal methods.

No Cessation in Construction of the Calumet-Sag Channel

Despite the pending suit to determine the amount of water that may be diverted from Lake Michigan by the Sanitary District of Chicago, work on the Calumet-Sag Channel is progressing at a rapid rate. More than $2,000,000 has been expended, ten out of seventeen contracts for sections covering one-half of this $12,000,000 ditch, which is to reverse the flow of the Little Calumet River, as the Chicago River has been reversed, have been let and work on them is under way. In fact, several miles of ditch are completed. The local press and various objectors have repeatedly brought up the query as to why this work has gone ahead before it is known how much water can be taken, and also in the face of the recent adverse decision of the Secretary of War in permitting only 4167 sec.-ft. of water to be used, while the main channel has already a capacity of 14,000 sec.-ft. The Calumet-Sag Channel is designed to carry 2000 sec.-ft. by gravity from a point in Blue Island 15 miles to the main channel. An intercepting sewer is to be constructed, beginning next summer, paralleling the Calumet River from Lake Michigan to Blue Island, at which point pumps will raise the sewage into the reversed flow of the river. This district, with its contributory population of 300,000 people, has been paying sanitary-district taxes for many years and enjoying the unsavory reputation of a typhoid-infected locality. The death rate in the Calumet region of Indiana is from two to five times that of Chicago proper, where no sewage is allowed to enter the lake. Just across the state line in the Calumet region of Illinois the former typhoid rate approximated that in Indiana, but for the last year it has been kept down by the use of bleach. The North Shore channel has been constructed to carry 1000 sec.-ft. of water to dilute the sewage from the north side. It will shortly serve the purpose for which it was constructed when the intercepting sewers through Evanston and other north shore towns are completed. Actual work on these sewers will proceed in a short time. It is, therefore, but following out the program laid out years ago by the early engineers of the district to construct the Sag Channel and remove the sewage contamination from the water intakes extended into the lake opposite the southern end of the city.

When the suit, referred to above, was instituted it included adjudication of the right to divert water through the Calumet only. This spring it was amended to include the entire diversion. It will require several months to complete taking the testimony. Should the decision be unfavorable to Chicago, an appeal will probably be made to the Supreme Court, so that a final decision is unlikely within two or three years. In the meantime the interest on the bonds must be paid and the people continue to drink infected water. It is stated that the legal situation is not different from the one that existed when the work on the Sag Channel was started three years ago. The Secretary of War has granted a permit to build the channel, reverse the flow and cause the water to flow through the channel from Lake Michigan. There is water enough in the Calumet, according to the officials, for dilution purposes for some time to come without taking any from Lake Michigan—that is, in the dry season and at flood periods there is an abundance. A portion of the water entering the Chicago River under the present permit may then easily be apportioned to the Sag Channel in case no further diversion is allowed. By an estimated expenditure of less than a million dollars controlling works can be constructed to regulate the outflow from the Great Lakes at suitable locations. Such a sum seems insignificant compared with the $75,000,000 total outlay by the city and the sanitary district, which has resulted in reducing the typhoid rate from 180 to 8. It is not the policy of the trustees to abandon work on the Sag Channel but to push the work to completion at as early a date as possible.

An additional sidelight on the matter is furnished by the passage of a law by the Illinois legislature providing for the diversion of 3 1/3 sec-ft. per 1000 persons, a total with the present population of 7500 sec.-ft.

Transportation and City Planning

Abstract of Paper by Milo R. Maltbie, Read before the City-Planning Conference in Chicago, May 6

Transportation and transit facilities are of the greatest importance in solving the problems of housing and congested living conditions in the larger cities. With ample low-fare, rapid-transit lines between the suburban districts and the business and manufacturing sections of the city the tenement house can quite often be supplanted by the two-family house or the cottage. Without the necessary transportation facilities congestion in cities is sure to occur. As evidence of the awakening of American municipalities to this fact may be taken the lively interest shown in the discussions of a paper on transportation and city planning by Mr. Milo R. Maltbie, member of the Public Service Commission, New York City, at the city-planning conference in Chicago on May 6.

There is no one factor, with the possible exception of topography, in Mr. Maltbie's opinion, which has a greater influence, not only upon the direction of city development but upon the character of the city from every standpoint, than transportation. The city which has the cheapest, most rapid and most convenient transportation facilities, other things being equal, has the most productive and healthful citizenship. It is not so much a question of distance as of time and convenience. As the area which may be reached varies with the square of the radius, if it is possible to go twice as far from the center in one city as in another during the same length of time, the available area is four times greater in the first instance than in the second. With the same population the density of the area inhabited need be only one-fourth in the first place of what it is in the second, and single houses, two stories in height, will house the same population that in the second case would necessarily be housed in tenements in solidly built rows from four to six stories high.

Value of Straight Streets

There is a marked tendency among city planner sto use curved streets. Cheap rapid transit would be practically impossible in a city wholly composed of curved streets or streets which change their direction frequently. The cost of construction would be large, operating expenses would be increased, and cost of maintenance and repairs would be heavy. Curves reduce speed and reduced speed means increased time in transit. An increase in time means a reduction in the area which can be served, which in turn is the cause of congestion. But it is not necessary that the entire city be checker-boarded. In residential areas between main lines of traffic there is ample room for exercise of ingenuity in geometrical combinations which may be beautiful and attractive, but these areas ought not to be placed where they will interfere with the extension of through transportation lines.

The close relation between the various factors in city planning can be seen in another direction. Prompted in a large measure by considerations of health, foreign cities have generally recognized the principle that the height of buildings must have some relation to the width of streets, but the relation between transportation and height of buildings has been little considered. It is obvious, however, that as buildings increase in height the demand for transportation increases. In the lower part of Manhattan the street plan is practically the same as it has been for generations. All of the available streets will soon be occupied by rapid-transit lines, and unless additional streets are cut through it will be necessary to limit the height of buildings. Provision must also be made for the transportation of materials, and even now it is apparent that if they are to be handled economically some other means than their distribution by truck or drays from distant freight terminals must be made. If freight subways are to be built, they must be located below the passenger subways, with all the attendant inconveniences.

The correlation of the various facilities for transportation of passengers is probably the most important, and perhaps the most difficult, phase of the problem. Terminals should be eliminated as far as possible. They are costly to acquire, expensive to maintain and increase rather than decrease congestion. So far as possible the lines should be operated direct through the city.

It is almost impossible to utilize the same set of tracks for interurban, suburban and purely urban business, though the first two classes may often be combined. No railroad should be relieved of its obligation to concontribute to urban transportation merely because it finds the suburban and interurban business more profitable and more easily conducted. It is essential that the interurban and suburban lines be so located that they shall have a relation to the purely urban facilities. It is practically impossible for trunk lines to provide for the complete distribution of passengers. For this general distribution other means of transportation must be provided, and in order that all facilities may successfully perform their functions there must be a correlation and unification of some sort.

Success of Subways

The question of cost is a factor which must not be overlooked. The success of subways in a few cities has given rise to the idea that every city should have subways and that all will be profitable. This is a mistaken notion, and the experience of London shows that there is no particular financial virtue in an underground railroad and that unless it is properly located and made a co-ordinate part of a comprehensive system it is likely to have limited success. Subways are expensive to construct, and the large cost of construction means large fixed charges. In order to offset this burden there must be dense traffic or many persons riding short distances. Dense traffic, however, means congestion of population. Areas given over to private houses, each with its own grass plot and garden, cannot furnish a sufficient population to support a subway unless the ride is very short and the rate of fare high. The area naturally tributary to a subway or any line is also limited in extent, for experience has shown that persons will not ordinarily walk more than ten minutes to reach a point where they can board a transportation line. Unless the city is to enter a new field of activity, therefore, or in some manner prevent the inflation of land values, or defray part of the cost of subways, it is impossible for cities to have subways unless at the same time they are content to have congestion. The city which desires to avoid density of population and to further the garden-city idea must resort to other means of transportation or solve the financial problem.

No matter how the cost of rapid-transit lines be paid, their construction results in increased land values, and if the city were to build lines by taxation so that there would be no fixed charges to be paid and fares reduced accordingly the increase in the land values would be still greater and the land owner would ultimately reap the gain which comes from improved transportation facilities. Unless there is some restraining influence, this increase in land values would be followed by the erection of tenement houses, and consequently congestion. But the increase in land values is not the original cause of congestion, it is rather the effect of congestion. The land values would not increase if it were not possible to secure a return upon such increased value. If the possibility of a large return were eliminated the values would not increase.

However, the cost of rapid-transit lines does have an important bearing, for the smaller the construction cost, the greater the number of lines that can be built, and if many lines are constructed and many areas are opened to development the competition between these areas would tend to keep prices down. Consequently, more attention should be given to reducing the cost of rapid-transit lines.

Transportation of Freight

The transportation of freight is not less important than passenger transportation. The cost of living, so far as it is affected by the cost of food products, is to a considerable extent a problem of transportation. What is true of food products is true of all material. If the means of transporting raw materials to the factory and manufactured goods from the factory to a consumer are inadequate, expensive and slow, the cost of the product will naturally reflect these conditions. It is essential, therefore, that in every plan of city development provision should be made for a prompt and cheap method of distribution. Thus far the railroads and steamship companies have assumed that their function ended with the provision of terminal facilities somewhere within the boundaries of the city. Doubtless this is fairly satisfactory in a small city where the terminals are not far from any part of the city, but in metropolitan centers such a plan is quite unsatisfactory. Food products must go to every home, and consequently the facilities for their distribution must reach every part of the city. In this connection the country trolley and the city street-car line have not been fully utilized. During the night time and early morning hours these lines are practically unused. The cost of operating cars at these times would entail practically no fixed charge and the operating expenses would be small. If the country trolley roads should establish collection points at short intervals, and if the products could be brought into the very heart of the city and distributed in the early morning hours, a very valuable and useful service would be performed. The street-car system could also be used for the distribution of freight to railroad centers, and thus connections established to the more remote districts tributary to every large city. Even the rapid transit lines might be utilized if found necessary during the night hours. From midnight till morning nearly every transportation system is either out of use or very little used, and yet during that time an immense amount of property could be transported quickly and easily without interference with the passenger traffic.

In the very largest cities this or some special plan will probably be necessary within the near future. The situation has almost reached this stage in New York City, and propositions have already been made for the construction of subways and elevated lines for the distribution of freight. It is proposed to break up carload lots at some point, such as the Jersey Meadows, northern Manhattan or the Bronx, and to run small cars into the congested portions of Manhattan, extending the system as necessary.

Municipal Control

As long as the various transportation facilities are in the hands of private individuals controlled by different corporations it is obvious that they cannot be brought into correlation and each made to serve the public in a proper way without a superior force. Each ought not to be permitted to carry out its own wishes regardless of its relation to other facilities. It is absurd, in Mr. Maltbie's opinion, for a company to locate a terminal removed from other transportation facilities and insist that the city provide means for distributing the traffic which it brings to this inconvenient point. What is proper and adequate in one generation is often inadequate and ill-suited to the demands of the succeeding generation. Consequently, there must be public control over the first location or first scheme of development and over subsequent extensions in order that the varied interests may be continually kept in harmony and the ever-changing needs met by changes in transportation facilities. The city should always be in a position where it can dominate the situaton.

The Channel Piers of the Hawthorne Avenue lift bridge, Portland, Ore., are pairs of concrete cylinders connected at the top by reinforced-concrete vertical diaphragms transverse to the bridge axis. They support tall steel towers carrying the counterweights and ropes for operating the lift span. The vertical tower columns are in the planes of the bridge trusses, but are braced by inclined posts in vertical planes transverse to the bridge axis. The lower ends of these braces are supported on long reinforced cantilever extensions or solid web brackets projecting from the up and down stream sides of the pier cylinders. This construction simplifies the structural steelwork, without increasing the volume of submerged substructure, and requires a minimum of reinforced concrete. Messrs. Waddell & Harrington, of Kansas City, were the designing engineers.

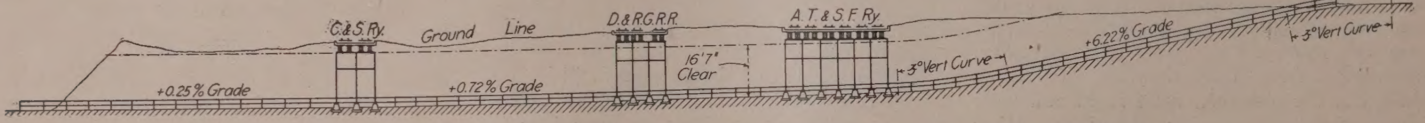
Alameda Avenue Subway in Denver

Construction and Unit Costs of Undercrossing Built Conjointly by the City, the Street Railway Company and the Railroads

The Alameda Avenue open-cut subway, 1256 ft. long, with gravity retaining walls 61½ ft. apart, completed in 1912, passes under eleven railroad tracks entering Denver, Col., from the south at a point where the roads are closest together. Elimination of grade crossings for traffic to the north side of the city has been accomplished by viaducts over the tracks, but at Alameda Avenue topography indicated that a subway was more feasible.

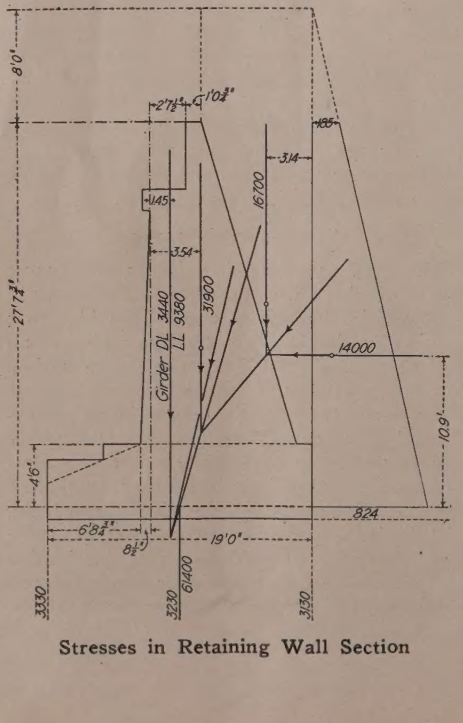
The north side of the subway is given over to a roadway and the remainder to two tracks for the tramway company, spaced 11 ft. apart, center to center. A gaspipe railing divides the roadway from the tracks, and the bridge columns are on the same line—that is, 4 ft. south of the center. The roadway is paved with 6-in. Lyons sandstone paving blocks bedded in a 2-in. sand cushion laid on a 6-in. concrete base. Curbs consist of 5 x 15-in. blocks of sandstone. Next to the north wall a 4-in. concrete sidewalk is laid on 3 in. of sand and gravel.

The combined gravity-retaining wall and abutment section is shown in one of the drawings, in which may be noted the extended reinforced toe under the subway for the purpose of equalizing practically the bearing pressure. The supporting material was stiff yellow clay, and experiments indicated that uneven pressures would likely cause a movement. Of the material excavated the first 5 ft. were sand and loam, under which a coarse gravel was found. Owing to the high water table the continuous concrete footings were placed under water, as it was found impossible to keep the trenches dry without removing some of the cement. After a 6-in. layer of concrete was deposited the steel reinforcing was laid on top of it.



Profile of the Alameda Avenue Subway, Showing the Relative Location of Those Railroads

Expansion joints in the walls at 30-ft. intervals consist of painting the end of one section with a mixture of tar, cement and coal oil to prevent adhesion. Five 1½-in. shear bars 3 ft. long were inserted in each section and fitted into steel sleeves extending 18 in. into the adjacent section.



Stresses in Retaining Wall Section

Bridges and Waterproofing

The railroad tracks cross the subway at an angle of 67 deg. The Santa Fé has six deck-type bridges for as many yard tracks, while the Denver & Rio Grande has three bridges of a similar type, two of which are for main line tracks. Two through-girder bridges support the main line tracks of the Colorado & Southern Railway Company. The 444 tons of steel were furnished by the Milwaukee Bridge Company and the American Bridge Company.

Single pedestals, with bases 8 ft. 4 in. square, support the center columns under the Colorado & Southern bridge. For the bridges of the other two railroads a continuous footing, 7 ft. 9 in. wide and 4 ft. thick, is reinforced by a row of five 60-lb. rails in the top and another row of five rails in the bottom.

As traffic had to be retained on all of the roads during construction, temporary wood trestles carried the tracks of the Colorado & Southern to the cut, which was spanned by steel through girders until the new abutments were in place, while in the case of the Rio Grande a détour was used.

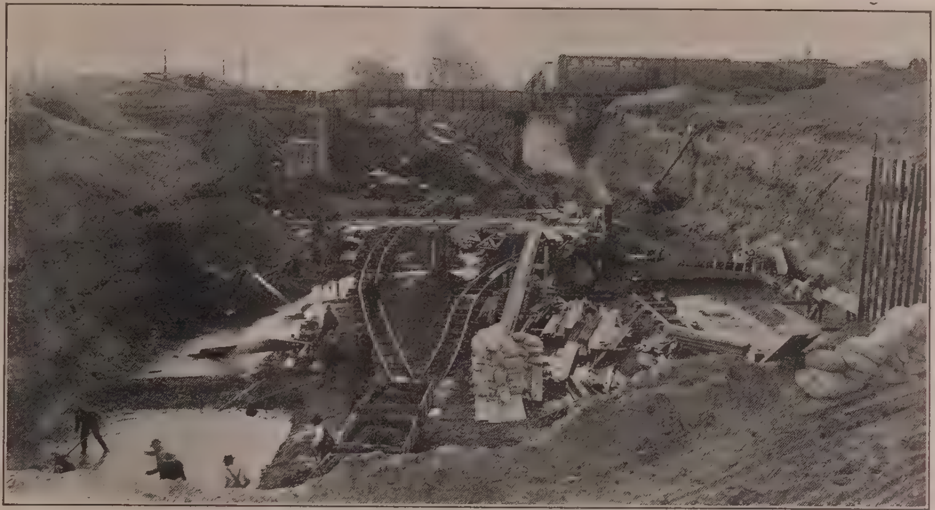
On top of the floorbeams creosoted timbers 8 in. square were bolted to the top flanges with hook bolts, the nuts of which were countersunk. Waterproofing was laid on top of this floor, first filling with asphalt all cracks and countersunk spaces. A three-ply layer of burlap mopped with liquid asphalt was then put on. On this was placed a layer of tar paper also mopped with asphalt. Over this, for protection from cutting by ballast and ties, was laid 1½ in. of Sarco mastic made of asphalt, flux and torpedo gravel, spread hot in two layers. The material was compacted while still hot with wooden floats. After cooling fine sand was sprinkled over the surface. At the ends of abutting ties, and also at the outer ends, the waterproofing was raised on 4-in. strips to drain the water toward the center of the tracks.

Excavation and Concrete

Beginning at the west end, where the natural elevation is about the same as that of the subway, a 35-ton 1¼-yd. dipper steam shovel, loading 1½-yd. Western dump cars, was used, the cars being hauled to spoil banks south of the west end by teams. Reaching the first set of tracks, work with the shovel was delayed until a wooden trestle could be built and tracks placed on it. A similar delay occurred at the second set of tracks, but here a détour was installed until the abutments were complete. After reaching the last set of tracks the remainder of the work was finished with teams.

Ground water was encountered several feet higher than expected over a bed of clay, in which practically all of the foundations were excavated. A drainage system of 18-in. pipe laid in the center was carried along behind the shovel. At intervals of 100 ft. branches of 10-in. pipe lead to the sides and connect with 6-in. lines paralleling the walls and receiving drainage from 4-in. weepers spaced 30 ft. apart.

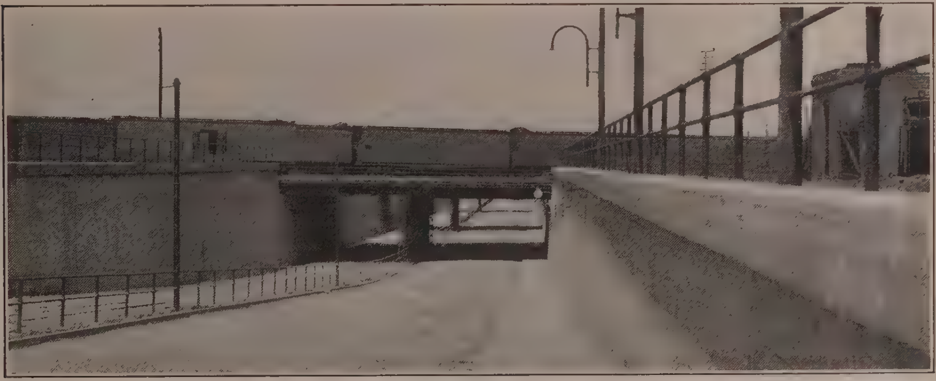
Most of the concrete was mixed in the center of the cut and then hoisted by a tower, from which it was discharged directly into the wall forms. Pit-run gravel, obtained from the excavation, was used without screening, making a 1:3:5 mixture. Much of the concrete was deposited in freezing weather, protection being obtained by heating the water and placing steam coils in the well-covered forms. With fifteen men 90 cu. yd. were placed in a nine-hour day. The Hinchman-Renton Fireproofing Company, of Denver, had the contract for the concrete work, but the engineers furnished all material except form lumber.



Excavating the Cut, as Seen from the Center of the Subway

UNIT COSTS

The Santa Fé bridge is 74 ft. 10 in. long and has six tracks 14 ft. 11 in. apart. In it were 222.48 tons of steel, 56,267 ft. of creosoted yellow pine and 6740 sq. ft. of waterproofing. For the three-track bridge of the Rio Grande, 75½ ft. long, with tracks spaced on 13 ft. 3-in. centers, there were 131.74 tons of steel, 25,642 ft. of creosoted yellow pine and 3130 sq. ft. of waterproofing. The Colorado & Southern bridge has two tracks, 15 ft. 3 in. center to center, and required 89.97 tons of steel, 18,896 ft. of creosoted yellow pine and 2293 sq.ft. of waterproofing. The total quantities—444.19 tons of steel, 110,805 ft. of creosoted timber, 12,163 sq. ft. of floor and 826 lin. ft. of single-track—and their cost are itemized in Table 1.



Entrance to the Completed Subway, as Seen from the East End

TABLE I—UNIT COSTS OF RAILROAD BRIDGES

	Cost per ton of steel	Cost per 1000 ft. of lumber	Cost per ft. of single track	Cost per sq. ft. of floor
Steel—				
Unloading	$0.616	.....	$0.331	$0.022
Erecting and riveting	6.339	.....	3.408	0.231
Material	63.063	.....	33.886	2.302
Painting	1.531	.....	0.823	0.056
Lumber—				
Hookbolts	.....	$4.427	0.540	0.037
Hardware	.....	2.341	0.286	0.019
Material	.....	51.000	6.220	0.423
Labor	.....	11.160	1.362	0.093
Curb Angles	.....	.....	0.181	0.012
Waterproofing—				
Sarco	.....	.....	2.926	0.119
Labor	.....	.....	0.832	0.056
Totals			$50.795	$3.450

The grading cost nearly $36,000, or $28.13 per foot of subway. It was distributed to 18,500 yd. of backfill, at 42.4 cents per yard; 41,690 yd. of team excavation, at 40.6 cents per yard, and 40,000 yd. of steam shovel excavation, at 27.9 cents yer yard. The steam shovel costs were apportioned as follows: crew, 15 per cent; labor on dump, 29 per cent; teams 22 per cent; repairs to shovel, 3 per cent; fuel, 12 per cent; and rent on shovel, 19 per cent. The 19,647 bbl. of cement cost $1.438 for cement and $0.089 for handling. Walls and pedestals cost $42.58 per lineal foot of wall and a total of $5.914 per cubic yard of concrete. The latter was distributed to cement, $1.618; handling aggregate, 12.6 cents; placing concrete, $3.31, and excavation 85.6 cents per cubic yard.

Handrailing of three 2-in. pipes on the bridges cost $1.13 per foot. In the subway a two-pipe railing of 2-in. and 1½ in. pipes cost 97 cents per foot. A similar 2-in. pipe railing on top of the walls between tracks cost 80 cents per foot.

Roadway costs were $11.045 per foot, apportioned to red sandstone pavement, $2.82 per square yard; red sandstone curb, 94 cents per lineal foot; and 24-in. brick gutter, 57.1 cents per lineal foot. The 6-ft. sidewalk cost 59.1 cents per lineal foot, the cement costing 2.7 cents; concerete, 6 cents; and the cushion, 1 cent per square ft.

Based on the following table an item, "Field Expense," including the time of men paid by the month while the force was not working on account of storms and delays, also time of watchman and incidental expenses not capable of distribution to specific items of cost, is 6.4 per cent of the net cost. Engineering was 5.06 per cent of the net cost plus field expense. It included plans, supervision, insurance, field instrument work and inspection.

TABLE 2.—APPORTIONMENT OF TOTAL COST

	Per Cent of Net Cost
Maintenance of railway traffic	2.56
Grading	17.10
Walls and pedestals	48.48
Bridges	20.00
Pavement	6.60
Sidewalk	0.34
Sanitary sewer	0.88
Subway drainage	2.54
Handrailing	1.50
	100.00

In apportioning the cost the city and the tramway company each paid a third, while the remainder was shared equally by the three railroads. To carry out the work these five corporations selected a board of engineers, made up of Messrs. J. B. Hunter, city engineer,

Work in Progress, the Concrete Chute Shown on the Left chairman; John Evans, chief engineer, Denver City Tramway Company, and H. W. Cowen, chief engineer, Colorado & Southern Railway Company. Messrs. Crocker & Ketchum were retained as consulting engineers and had direct charge of design and construction. The excavation and steel erection were done by force account. Mr. V. A. Kaufman was the resident engineer.

Reinforcing the Manistee River Viaduct

The 496-ton single-track, iron plate-girder viaduct of the Chicago & West Michigan Railway Company across the Manistee River, Michigan, was built in 1880 by the Detroit Bridge & Iron Company and was proportioned for a load approximately equal to Cooper's E-25. The traffic and loading gradually increased until in 1911 the Pere Marquette Railroad Company, which had acquired the structure, decided to increase the loading to Cooper's E-50, which required the strengthening or replacement of the old structure. As the viaduct had been well maintained and was in excellent condition it was found much more economical to reinforce it, which was accordingly done during the winter of 1911-12 by the Wisconsin Bridge & Iron Company in accordance with the general design originated by Mr. W. T. Curtis, contracting engineer for the bridge company, and described in a paper presented by him before the Western Society of Engineers.

Alternative Methods

The viaduct is 1170 ft. long and 75 ft. high and consists chiefly of one pin-connected 150-ft. river span and 30-ft. tower spans alternating with 45-ft. connecting spans. The trusses in the river span were about 18½ ft. deep on centers and with the girders of the adjacent five short spans were 14 ft. apart on centers. In the other spans the girders, all of them 3½ ft. deep, were spaced 8 ft. apart on centers. Each of the thirteen towers had four battered columns braced on all faces by horizontal struts and diagonal rods. The main girders were seated directly on the column caps.

Several methods of reinforcement were submitted and compared. One of them proposed a new full-length center line of plate girders supported on new vertical posts. This plan was discarded on account of the greater cost and the uncertainty of distribution of loads on the three lines of girders, the rotting of ties threatening unequal bearings on the center and side girders. The interference with traffic by the erection of the new work would also have been a disadvantage.

Other plans proposed the construction of new tower posts and new girders parallel to the existing ones, thus virtually involving the construction of a second light viaduct combined with the first, a scheme which was rejected on account of the prohibitive cost and the unsightly appearance.

The Plan Adopted

The plan as adopted was believed to be original for this work and consisted essentially of introducing a new center line of girders and truss in the river and end spans and supporting them on vertical posts, while in the remainder of the structure the old longitudinal plate girders were trussed and received additional support by pairs of new battered posts in each tower bent. Additional wind bracing was provided, new piers were built for the new tower posts, great care was taken to adjust the distribution of the loads between the old and new structures, and the work was successfully executed with minimum disturbance of the old structure. This system of reinforcement virtually reduced the height of the towers about 12 ft., adding materially to the stiffness of the structure and preserving over most of the viaduct the two-point bearings of the track ties.

Girder Spans and Towers

The essential feature of the reinforcement was the conversion of the old girder span into lattice girder trusses about 12 ft. deep by a system of triangular bracing in the planes of the battered posts of the towers, connecting the bottom flanges of the old girders to new horizontal bottom chords with trough-shape cross-sections made of pairs of 6 x 3½ x ½-in. angles connected by tie plates. The diagonal members have I-shape cross-sections made of two pairs of angles riveted between pairs of connection plates engaging the outer faces of the vertical flanges of the bottom chord angles and riveted through horizontal connection angles to the bottom flanges of the old girders. At the panel points of the new trusses the girders were reinforced by new vertical web stiffener angles to which new vertical transverse frames were connected. The ends of the bottom chords of these trusses are seated on the tops of battered posts forming a V in each tower bent, with foundations of piles driven both sides of the old bent. The new posts were braced together and were riveted to the old tower members wherever convenient. The bearings on the new piers were made with special double wedge shape pedestal bases adjusted by screw rods. The sliding surfaces were lubricated with "Velvet No. 2" and provide a vertical adjustment of ⅛ in. for a horizontal movement of 3 in., enabling the bridge inspector with an ordinary large wrench to make an adjustment compensating for any inequality of bearing.

The new battered posts are made of pairs of 12-in. channels on opposite faces of the old posts. They were shipped separately with the lattice bars shop-riveted to one channel and very carefully located to prevent interference with the old members of the viaduct. Care was taken to avoid removing the pins through the old wind brace rods in the tower framing, but it was sometimes necessary for the connection of the new bracing. The diagonal rods in the sway bracing in the planes of the inclined end posts of the new trusses were connected to the latter through cast-steel brackets, with their ends secured by bolts to prevent the development of undue tension in rivet heads.

River Spans

The river span was reinforced by the addition of a third deck truss slightly deeper than the old one in the axis of the viaduct. The center panels of both top and bottom chords are horizontal, the former just clearing the old top lateral system, which was not disturbed. The end panels of both chords are inclined and intersect at the end pins, which are connected to swinging links suspended from the tops of new vertical posts, which carry the track loads to new piers and provide for temperature movement.

The new top chord is lower than the old top chords and a continuous longitudinal I-beam placed on it supports the center points of the track ties which were shimmed up to bearing. The I-beam webs were cut through to give clearance for the old lateral diagonals, which were taken out one at a time and restored. After the truss was erected a new top lateral system connected to the new top chords was installed to supplement the old one. On account of the difference in the depths and weights of the old and new trusses a slight difference in deflection was developed, which was provided for by placing heavy diagonal members in the transverse planes between the old and new trusses and thus connecting them together so as to distribute the loads from one truss to the other and make them all work approximately uniformly.

The erection was handled first by a derrick car and afterward by a locomotive crane. The new columns for the river span were erected and the top chord was assembled, suspended from the old structure by steamboat ratchets and connected through its permanent links to the posts. Single wooden posts were then erected at the ends of the span and the remainder of the truss was assembled to the top chord and connected and adjusted by twenty-four turnbuckles.

Erection

Allowance was made both in design and construction for possible irregularities in the old work and on this account a large number of holes were field-drilled that otherwise might have been made in the shop. Numerous field shims were provided to insure bearing adjustment and the old structure was defaced very little except by drilling about seven thousand new rivet holes. About two thousand old three-quarter rivets were cut out and their holes reamed to 15/16 in., and nearly twenty-nine thousand rivets were driven. Excepting the lateral and transverse braces, which were riveted, the field connections of the old structure were bolted, a fact which greatly facilitated the repairing. The careful preparation made for this work is indicated by the fact that thirty-five sheets of detailed drawings were prepared at a direct cost of $950 for draftsmen's wages. The new steel weighed 465 tons and cost $22,400, exclusive of $11,300 for the erection. The new foundations cost $10,200, making a total of $42,900, which was believed to be about one-half of the cost of a completely new structure.

Personnel

The work was executed in accordance with the requirements of the chief engineer of the railroad, Mr. J. F. Deimling. The detail drawings and erection were in direct charge of Mr. C. M. Pearson, assistant engineer, and Mr. F. A. Ross, engineer of erection for the Wisconsin Bridge & Iron Company.

A Serious Pipe Break occurred in the 30-in. steel lock-bar force main at the crossing under the International Railway Company's tracks in Lockport, N. Y., on May 13. Workmen for the railway company were excavating holes for trolley poles, and the rupture in the pipe, according to information received from City Engineer Julius F. Frehsee, was the result of a concussion caused by blasting the rock close to the pipe line. The rent in the pipe was about 5 ft. long and the sheets of steel were forced inward about 11 in. The lock-bar was broken completely in two in several places. The center of the rupture was located 5 ft. east of a butt strap. The blast caused the steel sheets in this 30-ft. section of pipe to separate, or pull out of the lock-bar practically the entire length of the pipe. It was necessary to remove two 30-ft. sections of lock-bar pipe which were replaced by five 12-ft. lengths of 30-in. cast-iron pipe. The repair work was finished May 16 at 6 p.m., the city having been without a water supply for a period of 78 hours.

A Low-Cost Drawbridge

The highway drawspan across the St. Joseph River at St. Maries, Idaho, although of moderate dimensions and ordinary construction, is interesting as an illustration of a simple, remarkably light structure, designed to meet the present necessities of a situation where a much more elaborate and expensive structure of the same dimensions would often be provided. It is remarkable in that it is located at an altitude of 2142 ft. above sea level, spanning a river said to be the highest navigable stream in the world. At this point the depth of the river varies from 40 to 60 ft. and the stream is navigated, except during two or three winter months, by a line of steamboats running regularly between St. Maries and Cœur d'Alene City, a distance of 40 miles, in which the fall of the riverbed is only 20 in.

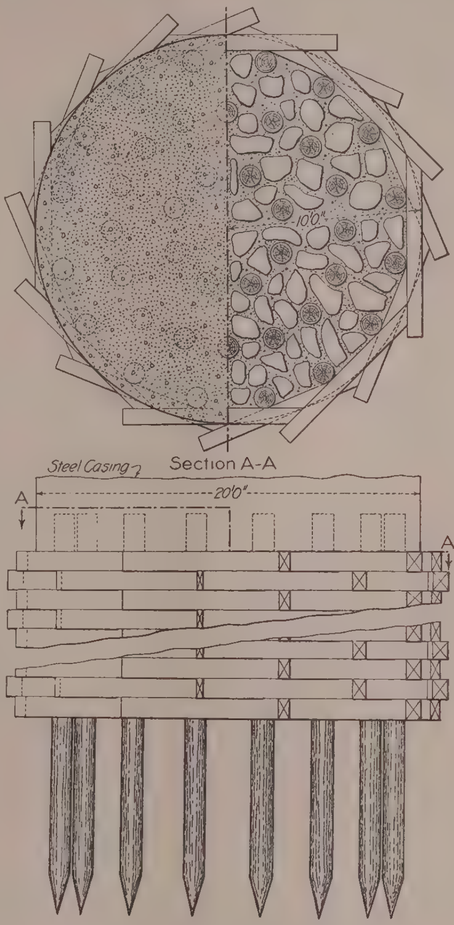
Superstructure

The steel superstructure, which is 228 ft. long, carries one 16-ft. roadway and gives two channel openings 100 ft. wide in the clear between the pile foundations. There are two full-length continuous riveted steel trusses 33 ft. deep and 17 ft. apart on centers, with top and bottom chords made of pairs of 9 and 8-in. channels and web members made of pairs of 5, 6, 7 and 8-in. channels and 2½-in. angles. All joints are riveted through pairs of ¼-in. gusset plates. There are portal braces on the main inclined posts and X-brace lateral angles between the 15-in. kneebraced riveted floor beams at panel points 17½ ft. apart.

The regular floor beams are riveted to the vertical posts at panel points through hitch angles extended above the top flanges of the beams, the bottom flanges of which are flush with the bottom flanges of the lower chords. The center floorbeams 8½ ft. each side of the pivot are of special construction to serve as main transverse girders carrying the full weight of the open spans. They are 3 ft. deep, with the ends notched to take bearing on the top flanges of the lower chords and are connected by double longitudinal girders in the bridge axis, which at the middle point rest on the top of the center pivot, with polished bronze discs set in a cast-steel base plate 3 ft. in diameter. The center panel between transverse girders is X-braced by main diagonals and at each corner has a pair of kneebrace struts making an angle of 45 deg. with the lower chords and carrying the bearings of four guide wheels running on a one-rail track 17½ ft. in diameter.

Wedge and Pivot Details

The end wedges are driven and pulled by adjustable links operated by a bell crank on a shaft driven by a bull wheel commanded by a steel rope carried under the bridge floor to the center pier. The bull wheel, which is 3 ft. in diameter, has a channel-iron rim and bent flat steel spokes riveted to the cast-steel hub. The vertical latch bar closes by gravity and is lifted by a line running over sheaves to the pivot pier. At each end of the bridge are provided bearing wheels, which travel on segmental track rails on the rest piers used to steady the bridge after the bearing wedges are drawn. The bridge can be swung by one man in three minutes with the ordinary hand gear and rack-and-pinion motion.



Concrete Pier and Crib

The pivot casting rests on a concrete pier cast in a steel cylinder 20 ft. in diameter, which is supported on a timber grillage with a footing of forty piles in a sixteen-sided crib made of octagonal courses of 10 x 12-in. timber, with staggered joints and sides in successive courses. The crib is filled with rock between the piles and with concrete.

All important machine parts are of cast steel, the shaft bearings being of cast iron and the floor and railings of wood. The weight of the steel in the superstructure, including the turntable and machinery, is 59 tons. The superstructure was erected by a floating derrick with a steam hoisting engine. The bridge was built jointly by the State of Idaho and the County of Kootenai. It was designed by Mr. S. W. Moore, engineer and contractor, of Portland, Ore., and was constructed under the supervision of Mr. T. E. Robinson, state engineer of Idaho. The cost of the completed structure did not exceed the limited appropriation available of $16,700, an amount which controlled the design. The steel was fabricated by the Milwaukee Bridge Company.

View of High-Altitude Highway Drawspan and Fender Pier

Rebuilding 3500 Feet of Trestle in Twelve Days

On June 15 3500 ft. of the four-track trestle across Newark Bay, N. J., used by the Pennsylvania and the Lehigh Valley Railroads were burned to the water's edge. Within a few hours men and materials were at the site, and at noon June 27 traffic was resumed on two tracks.

The tracks were about 26 ft. above high water. After the fire the burned piles were sawed off at the water level and 12 x 14-in. sills laid transversely across them. On these a new trestle was built, with 12 x 12-in. posts, the batter posts being about 20 ft. long. The tracks had been operated as two independent double-track railroads, each company using one pair of tracks. The rebuilt portion of the trestle carries only the two interior tracks, which will be operated jointly by the two companies.

Nine contracting firms took part in rebuilding the trestle, employing about 1000 men by day and 500 at night. The Pennsylvania Railroad worked from the east end and the Lehigh Valley from the west, finishing the work as they proceeded. The organization for the Pennsylvania consisted of the superintendent, principal assistant engineer, two division engineers, two supervisors, one assistant supervisor and three corps of engineers. Electric lights and a telephone system were installed and a physician was in constant attendance, although fortunately there were few injuries.

A train was caught at the time of the fire, and about thirty cars burned or fell into the bay. Many of these had steel frames and were removed with much difficulty, floating derricks being used for the purpose. Oxy-acetylene tools were used for cutting the steel rails of the burned structure so that they could be removed.

While the trestle was out of service the Pennsylvania suffered the greater inconvenience, as the Lehigh Valley was readily able to detour over the tracks of the Central Railroad of New Jersey east of Newark. The trestle afforded, however, the only direct access to the Greenville water terminal of the Pennsylvania, through which 800 cars are moved daily each way. Cars to and from New England were routed over the Poughkeepsie bridge, while those for other destinations were put through the terminals of other roads on the New Jersey side of the Hudson River, opposite New York City.

Mud Removal from Ohio River water by the water purification plant at Louisville, Ky., during 1912 amounted to 2100 lb. per 1,000,000 gal. of water filtered, or 26 tons daily. In the removal of this mud 49 per cent was taken out in the sedimentation reservoirs, 45 per cent in the coagulating basin, and 6 per cent by the filters. In the removal of bacteria 58 per cent was obtained through plain sedimentation, 34 per cent through coagulation, and 7 per cent by the final process of filtration. The whole system showed a total efficiency in the removal of bacteria of over 99 per cent.

Determination of Moments in Continuous Beams

By W. A. Slater, M.S., C.E., First Assistant, Engineering Experiment Station, University of Illinois, Urbana, Ill.

In consideration of beam problems the writer frequently makes use of a principle which he does not remember to have seen stated in any text book on mechanics, and with the application of which he believes many engineers are unfamiliar. The principle may be stated thus: In a beam of any span carrying a uniform load w per unit of length the moment curve is a portion of the parabola whose equation, referred to the vertex as center of co-ordinates, is $M = -wx^2/2$. Of course it is recognized by all engineers that the moment curve for a beam under uniform load is a parabola, but that it is always the same parabola regardless of the span or of the conditions of fixedness of the ends of the beam is not common knowledge, apparently, and this feature may be of considerable use in the solution of beam problems. In this equation the moment M is positive when clockwise, w is the load per unit of length of beam and x is distance along the beam. The demonstration of this principle, which is not complicated, is given herewith; also an example of its application.

Assume that at distance a (see Fig. 1) from any support of a freely supported or restrained beam the positive moment is a maximum. From principles of mechanics the shear will be zero at this point. Since the shear on any section is the algebraic sum of all the loads and reactions to the left of the section, the summation of reactions to the left of O—O must be equal to the summation of loads; i. e., $\Sigma R = \Sigma w$. These forces will then form a couple; and since the moment of a couple with respect to all points is the same, the moment caused by them at all sections to the right of O—O will be constant and equal to $e\ \Sigma R$, as shown in the figure. The additional moment at any section x distant to the right of O—O will then be caused by the uniform load applied in the distance x. Assume the intersection of the co-ordinates passing through the point of maximum moments as the origin of the moment curve and consider clockwise moment as positive. The equation of the moment curve then becomes $M = -wx^2/2$, in which M and x are as shown in Fig. 1. This is the equation of a parabola which is seen to be not a function of the span. Therefore, for a beam of any span having a uniform load, w, the moment curve will be a portion of the parabola having the equation $M = -wx^2/2$.

If, then, the position and amount of the maximum positive moments for any span be known, the entire moment curve may be drawn by laying off the span to scale and tracing upon it the parabola $M_1 = -wx^2/2$, placing the vertex of the parabola at the point of maximum moment and keeping the symmetrical axis of the parabola perpendicular to the direction of the span. The parabola will then cut the lines of the reactions at points whose ordinates represent to scale the moments at the supports. Conversely, if the values of the moments at the supports be known these values may be plotted to scale and the parabola superimposed upon the drawing in such a way that its vertex will show the position and amount of the maximum positive moment. Of course, in all cases the scale of the parabola must agree with the scale of the drawing. Since in the use of the theorem of three moments the moments at the supports are obtained first, the latter procedure is the one to be used.

Table 1—Cases of Loading for Continuous Beam

Case	First Span	Second Span	Third Span
1	Dead load only	Dead and live loads	Dead and live loads
2	Dead and live loads	Dead load only	Dead and live loads
3	Dead and live loads	Dead and live loads	Dead load only

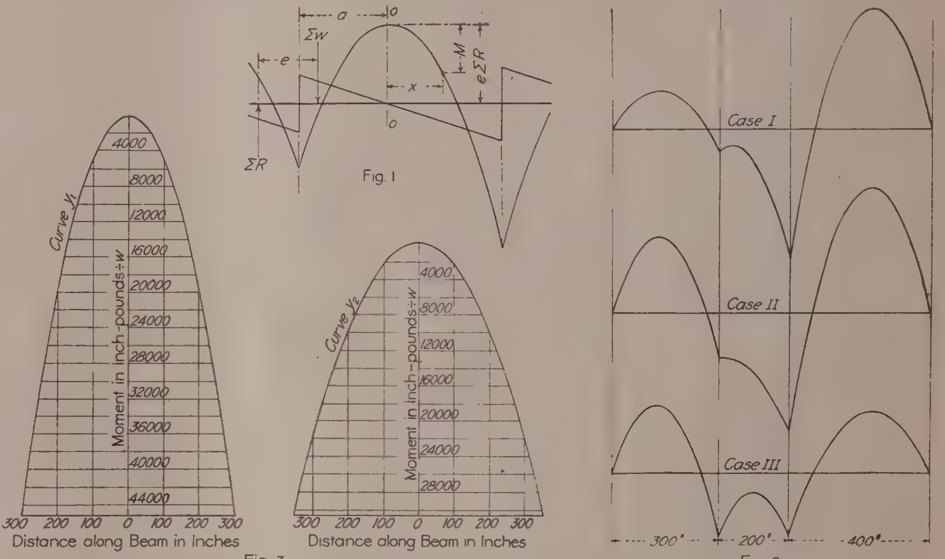
To illustrate the application of the above principle in the solution of beam problems the following example is given: Assume a freely supported continuous beam of three spans of 300 in., 200 in., and 400 in. respectively arranged as shown in Fig. 2. Assume a dead load equal to the live load; that is, equal to one-half the total load. Investigate for the conditions indicated in Table 1.

Since the beam is assumed to be freely supported, the moments at the end supports will be zero. Call the moment at the second support M_2 and that at the third support M_3 and let w be the sum of the dead and live loads per lineal inch. Table 2 gives the values of M_2 and M_3 in terms of w for the three cases. These values were calculated by the theorem of three moments.

Table 2—Moments at Supports

Case	Moments in terms of w	
	M_2	M_3
1	—2450	—14625
2	—5090	—13300
3	—7330	— 7100

Now choose a convenient scale and plot two parabolas having the equation $y_1 = wx^2/2$, and $y^2 = \frac{w^2\;x^2}{2\;\;2}$ respectively. These parabolas are shown in Fig. 3. The y_1 curve represents moments for total load and the y_2 curve represents moments for dead load only. For case 1 use curve y_2 for the first span and y_1 for the second and third spans. At the second support lay off a moment —2450 w. Superimpose curve y_2 upon span 1 in such a way that the symmetrical axis of the parabola is perpendicular to the direction of the span and so that the curve passes through zero moment at support 1 and through —2450 w at support 2. The curve y_2 then coincides with the moment curve of the beam between supports 1 and 2. In the same way superimpose curve y_1 upon span 2, causing it to pass through points representing moments —2450 w and —14625 w at supports 2 and 3 respectively. Curve y_1 will be used for span 3 also. For all spans under full load, curve y_1 will be used regardless of the span length; and for spans under dead load only, curve y_2 will be used. To determine the moment in inch-pounds at any point of any span, it is necessary only to multiply the corresponding ordinate of the moment diagram for that span by the value of w in pounds per lineal inch. It must be remembered that the moment has been reduced to terms of the total load and that for spans under dead load only, as well as for those under dead and live load, the value of w used must be the sum of the dead and live loads per inch of length. For instance, assume that the dead load and the live load are each 120 lb. per ft., or 10 lb. per in. of length. Then w = 20 lb. per in. In case 3, third span (under dead load), the maximum positive moment is scaled and found to be +3500 w. To obtain the moment in inch-pounds multiply +3500 by 20, which is the sum of the dead and live loads per inch, rather than by 10, the dead load only.



Figs. 1, 2 and 3—Diagrams for Determining Moments in Continuous Beams

Thus, with a slight amount of work in addition to calculating the negative moments, it is possible to determine and to show graphically the amounts and positions of the maximum positive moments and the positions of the points of inflection.

Even though the problem be not solved in detail showing the actual value of the moment at any point the principle here illustrated has been found to be of use to the writer in forming an opinion as to relative values of moments at various points of a continuous beam or at the same point of a beam under a variety of end conditions or of distributions of load.

Water Purification at Albany, N. Y., where Hudson River water is passed through a sedimentation basin, preliminary filters, slow-sand filters and finally receives a dose of hypochlorite, cost \$6.19 per million gallons, including pumping, during 1912, according to the report of Mr. J. B. Kilbourn, superintendent of the Bureau of Water. This cost is apportioned among the following items: Pumping, \$3.19; sedimentation basin, \$0.02; preliminary filters, \$0.56; slow-sand filters, \$1.15; laboratory, \$0.61; hypochlorite, \$0.35; superintendence, \$0.31. During the year 7,600,456,000 gal of water were treated. The average rate of filtration was 3,535,000 gal, per acre for slow sand and 81,000,000 gal. per acre for prefilters.

Dry Feed for Chemicals Used in Water Purification

By Allen Hazen, Consulting Engineer, New York

With few exceptions, the method of applying chemicals to water for its purification has been to make a standard-strength solution of the chemical in water and to apply this solution in measured quantities to the water.

A new method of regulating and applying the chemicals was used at St. Louis in 1904, described by Wall (Transactions, American Society of Civil Engineers, Vol. LIV, Part D, page 236). Under this method no standard solutions were prepared but weighed quantities of the chemicals were put in dissolving tanks at fixed intervals. A sufficient but unmeasured quantity of water was allowed to flow through these tanks, and as there was no permanent accumulation the amount dissolved was equal to the amount applied. The advantages of this procedure were the entire elimination of standard solutions and of the large tanks required for their preparation and storage, and the elimination of all the apparatus for measuring the rate of flow of the chemical solution.

ADVANTAGES OF DRY FEED

From the standpoint of simplicity and certainty this system offered great advantages over the standard-solution method formerly employed. It was open to the disadvantage of requiring constant and faithful attendance on the part of the men who weighed out the chemicals and put them in the dissolving boxes at five-minute or other intervals. This method of applying chemicals has continued in successful use in St. Louis. It has also been used with some modifications in the Cincinnati plant since 1907 and at Washington, D. C., since 1910. Notwithstanding the great advantages of this system, the practical disadvantage of unremittent attention on the part of the operators has prevented its general application in smaller plants.

In 1907 the writer designed for Brisbane, Australia, an apparatus for securing the advantages of dry feed in relatively small plants, but so arranged as to be automatic in character and capable of operating for considerable periods without attention. The mechanical details were worked out and tested by Robert Spurr Weston in co-operation with the writer, and a copy of the Brisbane apparatus was installed by Weston at Knoxville, Ky., and was successfully used in treating the water supply of that city.

SCREW CONVEYOR

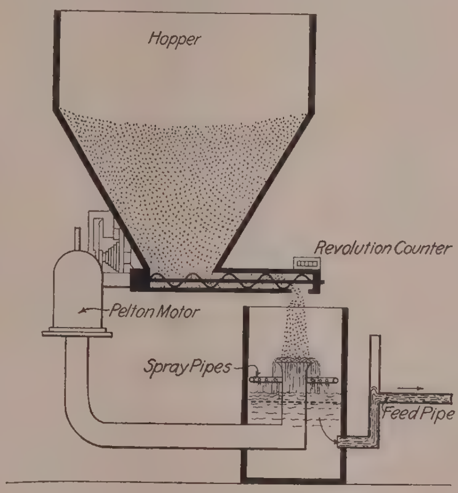
In this apparatus a screw conveyor operated in the bottom of a large hopper containing the dry chemical, and in such a state of physical subdivision that it would be steadily fed. Motive power was furnished either by an electric motor or by a Pelton waterwheel. The Pelton wheel is convenient where water under pressure is available, and the discharge from it goes to the dissolving box and is used for dissolving and carrying forward the chemical.

The speed of the screw is controlled, first, by a system of multiple gearing admitting of easy and wide change in speed between the motor and the screw, and, second, by changing the speed of the motor. A revolution counter attached to the screw affords a means of keeping an accurate record of the amount of chemical used.

Since that time similar apparatus has been installed by the writer in a number of plants with which he has had to do. Some improvements have been made in the design of the screw and in the screw setting, in the arrangement of the dissolving box, and in other details, but not in the essential arrangements. Somewhat similar apparatus has also been installed in some other waterworks plants, copied more or less closely from the plants designed by the writer.

PREVENTING CHEMICAL FROM SETTLING

It is essential for success that the chemical dropping from the screw should fall into moving water and that the movement should be sufficient to prevent the material from settling to the bottom and forming a pile in which it will cake solidly. In the earlier dissolving tanks it was found necessary to install mechanical agitating apparatus to prevent this condition, but with improved designs for dissolving boxes the mechanical agitators have been found unnecessary. It is also necessary to house the apparatus, as otherwise the dust resulting from it is troublesome. The accompanying sketch gives a general idea of the character of the apparatus.



Chemical Dry-Feed Apparatus

Sulphate of alumina, to be fed in this way, must be crushed to a smaller size than that which has been ordinarily used, but it is so furnished by manufacturers without additional cost.

Hypochlorite of lime, from a physical standpoint, is a more difficult substance to feed in this way. It has been fed experimentally, however, by putting an arrangement similar in construction to a meat chopper in the bottom of the hopper, above the screw, and operating it by the same motive power as the screw; this apparatus serves to break up lumps and to reduce the material to a size that can be handled by the screw.

Ordinary cast-iron screws and parts prove to be reasonably durable with the dry-feed apparatus and all parts subject to the action of chemical may be easily and cheaply replaced when that becomes necessary. The screws actually used have ranged from 2 to 4 in. in diameter. Our present preference is for a rather small screw operating at a relatively high speed.

RANGE OF SPEED

The apparatus installed at Springfield, Mass., and at Poughkeepsie, N. Y., had 4-in. screws built into the bottom of wooden hoppers and driven by variable-speed motors through a train of gears. These gears were arranged so that the ratio can be changed through a total range of 1 to 56, and as the speed of the motor can be varied through a total range of from 1 to 4, the total possible variation in speed with one screw is from 1 to 224. The machine can thus be made to work at any rate likely to be needed in the operation of the plant, and in fact the range provided is much greater than is actually required.

Tests of the apparatus at various speeds show that the discharge of the coagulants per revolution varies less than 3 per cent from the lowest speed to the highest. This makes it easy to adjust the machine for any rate of feed with all necessary precision. A tachometer, or speed indicator, connected with the machine allows a more rapid and also a more accurate adjustment of the rate to the desired conditions.

CAPACITY OF CONVEYOR

A 2-in. conveyor will discharge, according to the gearing, from 1 to 3 tons of coagulant per day, or sufficient to apply 1 grain per gallon to as much as 40,000,000 gal. per day, while, on the other hand, it can be run slowly enough to treat as little as 100,000 gal. per day. With a 4-in. conveyor the quantities are correspondingly greater.

The advantages of the dry-feed system are certainty of operation, compactness and moderate cost of installation, convenience and the elimination of much apparatus and piping hard to keep in order and tight with highly corrosive solutions. As compared with the St. Louis system constant attendance is made unnecessary, an important matter in small plants. Several years' experience with sulphate of alumina has been altogether favorable, and there is no reason why other chemicals may not be fed in the same way.

There are no patents on this method of applying chemicals.

Driving Piles with an Inverted Machine

A recent paper on the Manistee River viaduct, presented to the Western Society of Engineers by Mr. W. T. Curtis, described some unusual work in pile driving and pier construction for the foundation of additional supports for the viaduct. Nearly 400 piles were driven to a penetration of 35 ft. in clusters of 6 and 12 on both sides of and close to the bents of the existing viaduct towers.

All of the piles were driven through an old corduroy road which was discovered several feet below the surface of the ground and caused much difficulty and expense in removing or cutting through the logs. The pile driver had to be moved several times for each cluster of piles and was handled very advantageously from the deck of the bridge 75 ft. above the surface of the ground. The pile-driver tower, suspended from its center of gravity, was turned bottom side up and lowered between the tower bracing to the required position, where it was braced or guyed and a hammer operated between its leads to drive the piles as required. The engine was moved separately from the driver and the work was carried on without removing any of the old tower bracing.

Sand and gravel for the concrete piers were dumped through the track above to stock piles formed on grillages of old ties set on the surface of the ice 75 ft. below. The materials were distributed over the ice, mixed at the forms and deposited under water in very cold weather. The work was executed by the Wisconsin Bridge & Iron Company, of Milwaukee.

Flood-Prevention and Water-Conservation Measures in Germany

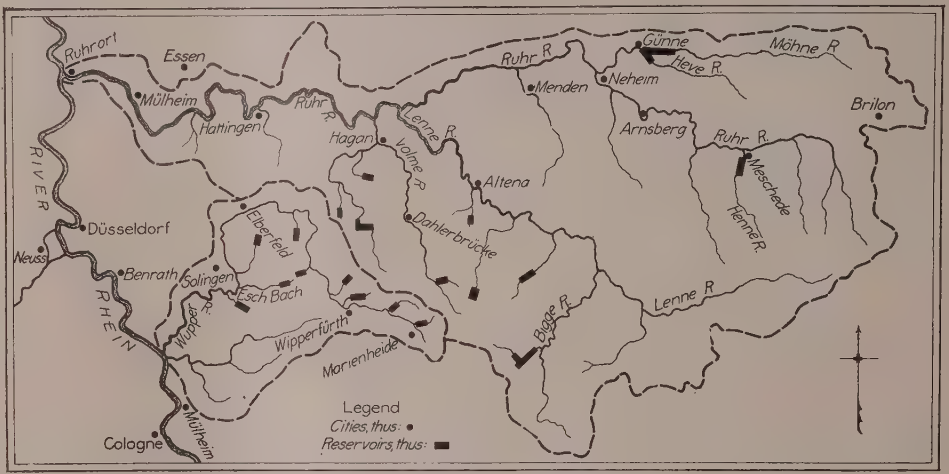
Summary Indicating the Extent and Magnitude of the Reservoir Systems in Operation and under Construction

The construction of reservoirs for water conservation in Germany dates back to the sixteenth century, when not less than seventy earth dams forming reservoirs with a total pondage of 350,000,000 cu. ft. were constructed in the Harz Province. The largest of these, the Oder Reservoir, holds about 60,000,000 cu. ft. Only during the past twenty years, however, have water conservation plans been developed to any large extent. During this period thirty reservoirs, with a capacity of 4,700,000,000 cu. ft. have been constructed at a cost of $13,500,000. Twenty more are either in course of construction or about to be begun and when completed will hold about 17,000, million cu. ft. Plans are also being prepared for a number of others.

The situation in Germany was studied last year by Mr. Kenneth C. Grant, assistant engineer of the Pittsburgh Flood Commission, who recently delivered a lecture on the subject before the Engineers' Society of Pennsylvania. The following information has been taken partly from his paper and partly from the "Zeitschrift für Bauwesen."

The accompanying table and plans show that in two districts, especially, large reservoir systems have been built in Rhineland-Westphalia and Silesia. West of the Rhine only one reservoir—the Urft—is in operation; but at Roetgen-Aachen an additional one which will have a storage of 330,000,000 cu. ft. is in course of construction. East of the Rhine, in the drainage basin of the Wupper River, are eight reservoirs, totaling 670,000,000 cu. ft.; while in the Kerspe Valley at Ohl another, with a capacity of 550,000,000 cu. ft., is in course of construction. These reservoirs, together with nine in the drainage basin of the Ruhr, are built primarily to supply domestic and industrial requirements, but will also be used for the generation of power.

The credit for the undertakings on the Ruhr is mostly due to the Ruhrtalsperrenverein, which was formed in 1898. The dams, however, are built by private associations, assisted financially by the Imperial Government. The Verein buys its supply from these private associations. The cost of water varies with the locality; at Heilenbecker the price is $95 a year, or about $6 per 1,000,000 cu. ft.; at Fullbecke, $960 and $46 respectively; at Hasperbach, $4800 and $66; and at Ennepe, $24,000 and $66. The highest price, $68 per 1,000,000 cu. ft., is paid at Glörbach, Jubach, Henne and Oester.



Reservoir System in Rhineland-Westphalia on the Wupper and Ruhr Rivers

Another example of co-operation, but on a somewhat different basis, is to be found on the Wupper River, a tributary of the Rhine above the Ruhr. It has a drainage area of about 240 sq. miles and flows through the thickly populated manufacturing region around Barmen and Elberfeld. Before the construction of reservoirs on its tributaries the stream had a very irregular discharge, varying between 0.05 and 90 sec.-ft, per square mile of drainage area. Flood damage was frequent and considerable, and the numerous water-power plants suffered greatly from low water.

After long deliberation a reservoir association was formed under a special Prussian act. This association has already built two reservoirs on tributaries of the river and a third is under construction. All water users below these dams must pay an annual assessment to the association.

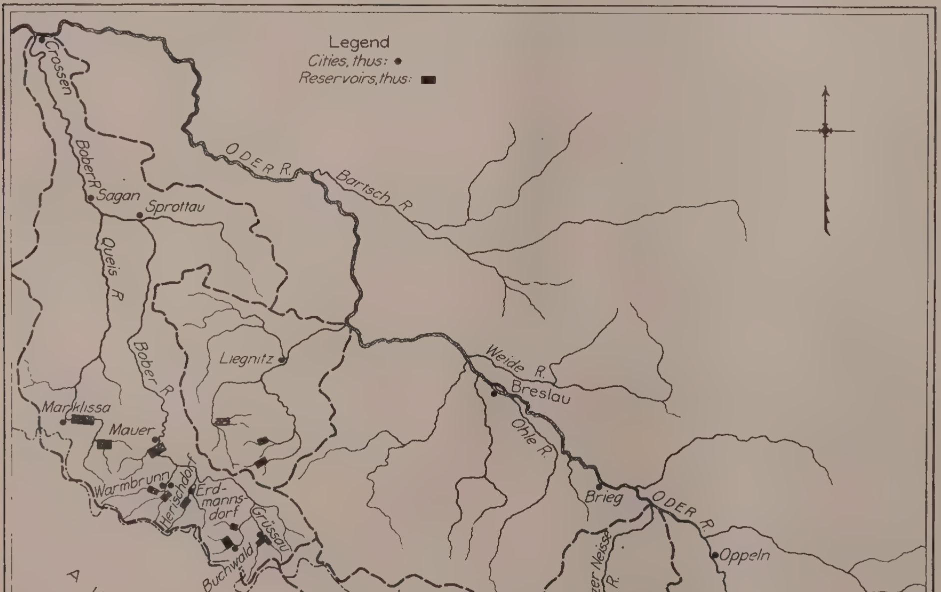
In addition to these three projects there are six other reservoirs on tributaries of the Wupper, built by cities for domestic and industrial supply, while a seventh is under construction on the Kerpesbach for an additional supply to the city of Barmen. Contrary to the arrangement on the Ruhr, the Wupper association has been given complete control over the entire watershed, so that all reservoirs built since the act creating the association took effect must pay a certain amount annually, based on the water used, to the association. These projects, while primarily not operated for flood control being always kept as full as possible, have an appreciable effect in lowering the floods in the Wupper.

RESERVOIRS IN SILESIA

The reservoir district in Silesia is located in the Riesen and Eulen Mountains. The object is not only to safeguard life and property but to make the Oder River navigable during times of low water. When a flood comes only so much water is released as will safely pass down the channel. The water held in storage is later used to increase the low-water flow. The cost of building these structures was estimated at $9,300,000, $7,150,000 of which was granted to the Province of Silesia by the government.

Sixteen reservoirs were planned, of which seven, with a capacity of 1,050,000,000 cu. ft., have been completed at a cost of $1,900,000. Six more, with a capacity of 2,290,000,000 cu. ft., estimated to cost $2,580,000 are in course of construction.

The Oder River flows in a northwesterly direction through Prussia. It passes only 50 miles to the east of Berlin and as it is connected with that city and thence with the Elbe River by canals, and is navigable for nearly its entire



Reservoir System in Silesia on the Tributaries of the Oder River length, it is an important stream commercially. The head of navigation is at Cosel, in the southern part of Silesia; and from here to Breslau, the capital of the Province, a distance of about 90 miles, the river is canalized.

Below Breslau the low-water depth is about 3.9 ft., or 0.7 ft. less than that required for navigation. This depth gradually increases, but slowly, until at a point about 120 miles below Breslau the necessary depth of 4.6 ft. is attained. The extension of the system of locks and dams through this stretch was at one time considered, but it has been decided to obtain the additional depth by the construction, on tributaries of the Oder above Breslau, of two large reservoirs, which will perform the triple function of controlling floods, developing power and increasing the low-water stage. The required increase of 0.7 ft. in the stage below Breslau can be obtained by an additional flow of about 700 sec. ft. The plans for these reservoirs are now completed, but work is not as yet begun. They will be built under the direction and at the expense of the Prussian Government.

At Harzdorf, Grünwald and Friedrichswald the mill owners and others using the reservoir water for generating power will be taxed $12 per year per horsepower. In other localities a tax of $28 per horsepower per year will be levied.

Tabulation of Reservoirs Grouped under Their Respective Rivers

Name of reservoir	Construction period	Drainage area, sq. miles	Maximum capacity, cu. ft.	Reserved for flood control, cu. ft.	DAM Material	DAM Volume of dam, cu. yd.	Total cost of reservoir	Cost of reservoir per million cu. ft.
REICHENBERG RESERVOIRS								
Harzdorf	—1902	6.0	22,239,000	8,119,000	Masonry	20,918	$165,000	$7,419
Grünwald	1906–08	10.3	95,310,000	....	Masonry	56,218	540,000	5,770
Friedrichswald	1902–06	1.6	70,600,000	35,300,000	Masonry	54,911	360,000	5,100
Voigtsbach	1904–06	2.7	8,825,000	....	Masonry	15,690	94,400	10,700
Mühlscheibe	1904–06	2.6	8,825,000	....	Masonry	20,918	123,000	14,000
Gorsbach	....	4.6	17,650,000	8,825,000	Masonry	41,837	206,000	11,670
RESERVOIRS ON THE ELBE AND TRIBUTARIES IN BOHEMIA								
Königreiche-Walde	Not completed	200.0	320,887,000	256,000,000	Masonry	......	$965,000	$3,000
Spindelmühle	Comp. 1914	22.4	119,500,000	106,000,000	Masonry	......	652,880	5,464
Hlinsko	Comp. 1911	21.6	81,190,000	60,010,000	Earth	......	150,000	1,850
Parizov	Comp. 1913	80.7	60,010,000	....	Masonry	......	299,686	5,000
Kreibitz-bach	Not completed	2.5	35,300,000	14,100,000	Earth	......	140,000	4,000
Horka	Not completed	16.6	49,300,000	34,500,000	Earth	......	....	......
RESERVOIRS ON THE ODER IN SILESIA								
Glatzer Neisse	Not begun	906	3,600,600,000	635,400,000	Earth	......	$3,840,000	$1,070
Ma'apane	Not begun	403	3,124,050,000	370,650,000	Earth	......	2,880,000	900
RESERVOIR ON THE QUEIS RIVER								
Marklissa	1901–05	118	529,500,000	....	Masonry	......	$750,000	$1,418
RESERVOIRS ON THE BOBER RIVER								
Mauer	—1912	467	1,765,000,000	706,000,000	Masonry	332,000	$992,000	$1,150
Warmbrunn	1905–08	46	199,200,000	Whole reser.	Earth	......	381,000	1,800
Herischdorf	1904–06	36	141,200,000	Whole reser.	Earth	......	219,000	1,550
Buchwald	1904–06	23	77,660,000	....	Concrete	......	264,000	3,400
Grüssau	1903–06	36.4	28,650,000	....	Earth	51,100	86,000	3,000
RESERVOIRS ON THE RUHR RIVER								
Möhne	—1912	16.0	4,590,000,000	Inc. low-w.	Masonry	344,500	$5,000,000	$1,090
Helienbecker	1894–96	2.9	15,900,000	Inc. low-w.	Masonry	11,700	67,300	4,230
Fuelbecke	1894–96	1.85	24,700,000	Inc. low-w.	Masonry	20,000	79,750	3,795
Hasperbach	1901–04	3.1	72,450,000	Inc. low-w.	Masonry	74,500	507,500	7,000
Ennepe	1902–04	18.5	363,500,000	Inc. low-w.	Masonry	21,300	716,500	1,970
Verse	1902–04	1.8	58,300,000	Inc. low-w.	Masonry	31,350	179,000	3,360
Glörbach	1903–04	2.8	74,200,000	Inc. low-w.	Masonry	45,700	216,000	2,915
Jubach	1904–05	2.5	37,100,000	Inc. low-w.	Masonry	36,600	161,600	4,350
Henne	1901–05	20.4	388,300,000	Inc. low-w.	Masonry	140,000	805,000	2,070
Oester	1904–07	4.9	109,600,000	Inc. low-w.	Masonry	68,000	429,000	3,910
Lister	—1913	25.8	660,000,000	Inc. low-w.	Masonry	140,000	1,010,000	1,530
RESERVOIRS ON THE WUPPER RIVER								
Beves	1898–99	8.65	116,500,000	18,000,000	Masonry	......	$343,000	$2,950
Lingese	1898–99	3.55	91,780,000	3,500,000	Masonry	......	256,800	2,800
Brucher	1912–13	......	123,500,000	....	Masonry	......	....	......
Eschbach	1889–91	1.74	37,800,000	....	Masonry	......	128,640	3,640
Panzerbach	1891–93	0.54	10,590,000	....	Masonry	......	25,200	2,380
Salbach	1898–99	0.35	10,300,000	....	Masonry	......	122,400	8,670
Herbinghauser	1898–01	2.1	85,250,000	....	Masonry	......	480,000	5,440
Sengbach	1900–03	4.65	113,000,000	....	Masonry	......	504,000	4,603
Neye	1907–08	4.5	211,800,000	....	Masonry	......	408,000	1,930
Kerpesbach	Not completed	10.6	677,760,000	....	Masonry	......	....	......
RESERVOIR ON THE RUR RIVER								
Urft	1900–04	145	1,606,000,000	....	Masonry	185,650	$1,000,000	$620
RESERVOIR ON THE EDER RIVER								
Eder	....	552	7,144,720,000	....	Masonry	392,220	$4,745,000	$665
RESERVOIRS ON THE GLATZER NEISSE								
Setienberg	1905–08	19.85	40,650,000	....	Masonry	88,200	$68,300	$1,680
Wölfesgrund	1905–07	9.6	27,930,000	....	Masonry	26,200	125,000	4,460

REICHENBERG RESERVOIRS

The Reichenberg group is composed of six projects in northern Bohemia, on the upper basin of the Gorlitzer Neisse. This stream rises in northern Bohemia and flows northward for 124 miles, emptying into the Oder about 15 miles below Crossen in Prussia. The upper portion of the valley receives a heavy precipitation, 13.5 in. in twenty-four hours having been recorded at some points, and has been repeatedly devastated by floods. After a great flood in 1888 an association was formed to plan and carry out the construction of protection and regulating works, consisting of the widening and straightening of the channel and the raising and protecting of the banks. The estimated cost of these improvements was so heavy and their effectiveness so doubtful, however, that practically nothing was done by the association.

In July, 1897, this part of Europe was again visited by devastating floods, which so revived public interest in flood relief that a convention, in which all the neighboring cities and towns were represented, was held in Reichenberg in the fall of that year. At this meeting it was decided to investigate the feasibility of constructing reservoirs for flood control. In January, 1901, the preliminary studies were sufficiently complete to establish the general plans, which contemplated the construction of six reservoirs in the neighborhood of Reichenberg, controlling the run-off from about 29 sq. miles, and in critical flood times holding back about 3530 sec.-ft. of damaging flood discharge.

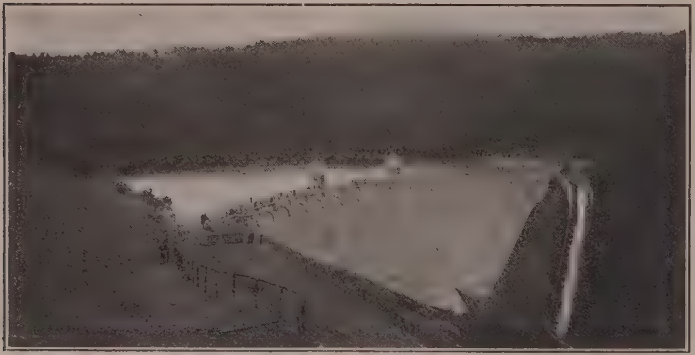
The result of the investigations gained the association many new supporters and assured the sympathy of the population of the entire valley with the project. In fact, one of the most noteworthy features of this undertaking is the widespread interest it aroused in the surrounding country and the universal financial support it received. Although all the reservoirs are located in Bohemia, the benefits both in flood control and increase of low-water

View of the Buchwald Reservoir Dam

Eschbach Reservoir Dam, with Outlet Tower flow are felt by the Saxon and Prussian interests along its lower course; and these two states, together with cities, smaller communities and private interests, co-operated with Bohemia in their construction. The total cost of the work was $1,320,000.

MARKLISSA RESERVOIR

This reservoir is located on the Queis River, a few miles above Marklissa. This stream rises in the mountains of southern Silesia and flows northward into the Bober River, which empties into the Oder a short distance below Crossen. The Queis flows parallel to and about 20 miles to the east of the Görlitzer Neisse, described above under the Reichenberg reservoirs, and in topography, rainfall and run-off is very similar to that stream, the same heavy rainfalls having repeatedly caused destructive floods on both streams.

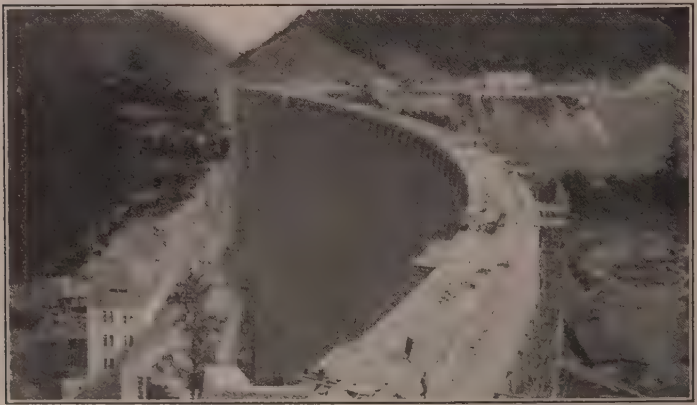


Sengbach Dam, Showing Narrow Stepped Spillway

Warmbrunn Dam Spillway, with Peculiar Discharge Openings

The drainage area above the dam is 118 sq. miles and the reservoir has a capacity of 529,500,000 cu. ft. It was built in 1901-1905 by the Province of Silesia at a cost, including land, damages, etc., of $750,000, or $1418 per 1,000,000 cu. ft. of storage.

The design of the reservoir is based upon a careful study of the flood of 1897, the greatest ever experienced in this region. The channel of the Queis at Marklissa will carry 3880 sec.-ft. without overflow. During the flood of 1897 the discharge rose to 27,530 sec.-ft., or about 230 sec.-ft. per square mile. The discharging apparatus at the dam is so arranged that 3880 sec.-ft. can be released during the filling of the reservoir. At the level where the capacity is 529,500,000 cu. ft. there are two spillways, one on each side of the valley, with a total crest length of 223 ft. As soon as the water reaches this level and begins to flow over the crests of these spillways, the gates below are gradually closed so as to keep the discharge at 3880 sec.-ft. As a head of 3 ft. on the spillway is necessary to give the allowable discharge of 3880 sec. ft., the additional capacity of 42,360,000 cu. ft. due to this added depth can be regarded as protection against floods, bringing the total capacity of the reservoir for flood protection up to 571,860,000 cu. ft.



View of the Mauer Dam Nearing Completion

View of Urft Dam, Showing Stepped Spillway

The reservoir is so arranged, by means of two lower spillways, that 176,500,000 cu. ft. of water are kept in the reservoir, but on the approach of a flood can be released by gates at the bottom in time to make the full capacity of the reservoir available for flood control. The lower reserve is used for the development of power at a station, a few hundred feet below the dam, which develops a maximum of about 3000 hp and an average of about 1500 hp.

The release of the flood water during the low-water season increases the flow of the Queis to about 140 sec.-ft., or about four times its former minimum, which is of great benefit to the numerous mills on the stream below.

There are twelve other reservoirs for flood control on tributaries of the Oder in southwestern Silesia. With three exceptions they have earthen dams. They vary in capacity from 16,930,000 to 120,150,000 cu. ft. and in cost per 1,000,000 cu. ft. of storage from $990 to $3060. All these reservoirs are built and operated for flood control only, being kept empty except during floods. The land below the flow line is used for pasture and raising hay. It is rented for about $3 an acre per year, which is about 1 per cent on the average cost, $300 per acre.

These reservoirs, it is stated, have been thoroughly successful in preventing floods in the valleys below the dams.

THE BUREAU OF SCIENCE in the Philippine Islands made 4563 tests of cement samples during six months in 1912 at an average charge of $1.20 a test.

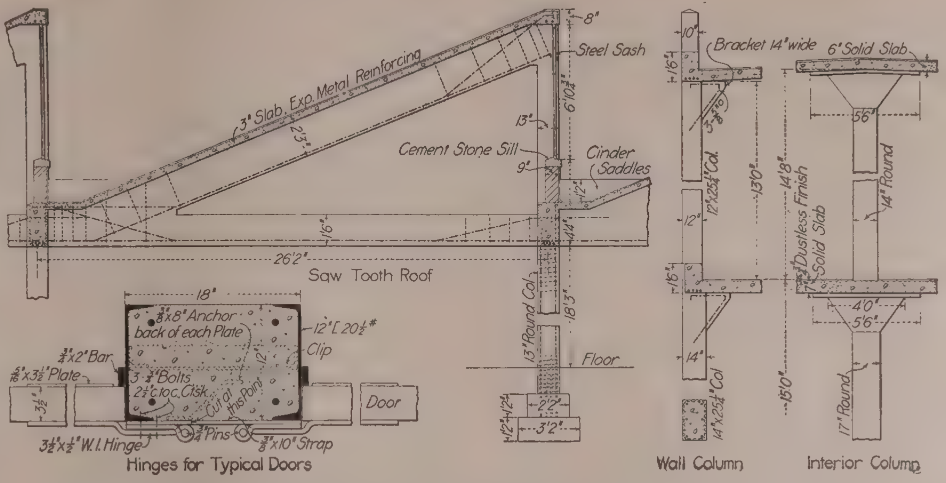
Sludge Disposal at Oldham

A patented process for the disposal of sludge is employed at the Oldham sewage works in England. It is the invention of Dr. J. Grossmann, who outlined his methods in a paper presented at the May meeting of the Institution of Municipal Engineers and which was abstracted in the "Surveyor" of June 13. Dr. Grossmann's process, it is claimed, produces an inodorous and sterilized manure of high value and provides for the recovery of grease, although it was not represented that the adoption of the process would be attended with large profits. The chief advantages seem to be the elimination of smell and flies.

Sludge from Oldham, a city of 147,000 inhabitants, is taken direct from the settling tanks and settled in special tanks until the percentage of solids is raised from about 10 to about 20. The next step is to dry the sludge. It is taken by an automatic conveyor to the top of the building, and thence led by chutes to six horizontal heated drying cylinders. In these are revolving screw conveyors, pushing the sludge along until it drops into hoppers in the form of a powder.

Each machine produces 1½ tons of dried sludge in twenty-four hours, which is equal to 15 tons of the original sludge. In the evaporation of the surplus water there is said to be no smell. To extract the grease which still remains in the dried sludge, the latter is passed through another cylinder into which superheated steam is admitted, along with a continual supply of sulphuric acid in the form of a slender stream no thicker than a knitting needle. The rotating paddles and shaft which carries them are perforated in such a way that the steam penetrates the whole mass of dried sludge and absorbs the grease and fat. The presence of acid is necessary for this action. The steam is finally led to condensers, where the grease separates out.

Reinforced-Concrete Details of a Large Paint Shop



Reinforced-Concrete Sawtooth Roof Frames, Wall Columns and Corbelled Columns

The 210 x 287½-ft. two-story paint shop for the Detroit United Railways is one of a group of four new repair shops of similar construction recently designed and now being built for the maintenance of over 2000 electric cars operated on the 777 miles of track. The building is divided by longitudinal walls and rows of columns into twelve aisles from 14 to 22 ft. in width.

One full-length longitudinal section of the shop is about 57½ ft. wide and consists of four two-story aisles. It is devoted to glazing and stripping and to storing of stock, and has upper and lower stories respectively 15 and 13 ft. high in the clear, the latter receiving its light through windows in the wall and through a monitor skylight. The remaining eight full-length aisles have a combined width of 121 ft. 8½ in. in the clear and, though only one story are of about the same overall height to the top of the transverse sawtooth roofs of 26 ft. 2-in. span center to center of supporting columns.

This portion of the building accommodates the paint shop and washrooms and has a gallery toilet. The columns, roof trusses, and roof and floor slabs are of reinforced concrete. The partition walls are of brick and the exterior walls consist almost entirely of windows, with steel sash in steel channel frames set in a short length of common brick walls 13 in. thick necessary to fill the remaining space between windows and columns. The rectangular wall columns have two-course offset concrete footings and the cylindrical interior columns have similar three-course footings, all columns being dowelled into their footings with five or six vertical ¾-in. rods.

The sawtooth roofs are carried on triangular trusses about 12 ft. high over all and 26 ft. 2 in. long on centers, each of which has a deep inclined girder or rafter thoroughly connected at the lower end to the horizontal member which it intersects and with which it is integral, and which takes the horizontal tension from the rafter, thus transmitting only vertical reactions to the column.

Columns

To secure the greatest clearance it was necessary to make the columns as small as possible. They were constructed with an external diameter of 13 in. and reinforced with six ⅝-in. vertical bars and with 5/16-in. hooping at a 3-in. pitch. The wall columns were made with rectangular cross-sections, and for the two-story portion of the building were provided with brackets under the ends of the floor of the roof beams. The interior columns in the two-story portion of the building are of circular cross-section and are corbelled out in all directions at the upper ends to support the second floor and roof slabs. The tops are thus enlarged to a diameter of 4 ft. and support "shear slabs" 5½ ft. square, 16 ft. 9 in. apart longitudinally and 18 ft. 10 in. apart transversely, on which the floor and roof slabs, respectively 7 and 6 in. thick, are carried. The roofs are proportioned for a live load of 40 lb. per square foot, and are graded by cinder concrete fill to drain to leaders at the columns. Over the sawtooth trusses the roof slabs are 3 in. thick and reinforced with expanded metal, and were cast in forms supported during construction on temporary rafters. All roof slabs are waterproofed with tar composition.

Lighting and Heating

The car doors, which are 12½ ft. and 16 ft. high, are of wood, with 3½ x ½-in. wrought-iron strap hinges extended across the full width of the leaves and anchored to the 12-in. reinforced channels in the wall columns. The sawtooth windows have pivoted sashes commanded by a continuous operating device. In the two-story aisles the large windows have six-light pivoted sections of sash for ventilation. The stairways are of reinforced concrete inclosed in 13-in. brick partitions.

The shop is heated by direct-radiation coils supported on the walls and on the sawtooth girders. Artificial illumination is provided by a liberal installation of tungsten lamps with deep bell shades for individual lighting, and by 1 B.C. multiple-series flaming carbon arc lamps to every 14 x 26-ft. section of floor space in the paint shop and washroom.

The paint shop is fitted with 14 Bowser tanks, of 170 to 550 gal. capacity, for storing oil and varnish and has a reinforced-concrete counter with a complete equipment of 20 x 26 x 27-in. tilting bins of 3/16-in. steel for the storage of paint powder. It is also provided with four solid-concrete washing tanks, 26 in. wide, 8 ft. long and 30 in. high, and with a concrete paint-mixing bench, wash sink and lye tank. Messrs. Smith, Hinchman & Grylls are the architects and Mr. W. E. Woods was the contractor for the building.

Second-Story Columns with Corbelled Tops

Construction of Shop with Sawtooth Roof

The Smoke Nuisance

The smoke nuisance in San Francisco is being studied by a committee recently appointed by the Chamber of Commerce. The committee spent some time gathering information as to causes and remedies, and then undertook to frame an ordinance intended to regulate the quantity of smoke permissible from each coal consumer. The committee also compiled two lists of furnace users, one listing places and persons who offended the least or not at all, a sort of "white list," while the other was the roll of the worst offenders, or "black list." The committee claims that the excessive discharge of smoke from chimneys is mainly a matter of efficiency in firing and believes that the nuisance may be greatly abated if firemen could be made to perform their work with greater care.

Suggested Methods of Preventing Land Slides

The prevention of land slides of an extensive area by an underground system of reinforced-concrete posts and tie rods has recently been proposed with particular reference to the conditions in the Culebra Cut of the Panama Canal. The scheme as developed by Mr. George S. Rice, chief mining engineer, U. S. Bureau of Mines, Pittsburgh, was described in a paper presented before the Western Society of Engineers on May 12. Mr. Rice has studied at first hand the conditions leading to the land slides on Turtle Mountain, near Frank, Alberta, Canada, in 1903, which caused the loss of seventy lives and the destruction of a large section of the town. Supplementing this study Mr. Rice has drawn, in the development of the plan, upon his experience in mining operations and upon a study of the conditions in the Culebra Cut, as outlined by Mr. Donald F. MacDonald in the Engineering Record of Aug. 31, 1912, page 228. The scheme in its application to the Panama Canal is briefly as follows:

1. To drill a series of holes placed along lines parallel with the axis of the canal, these holes to be both vertical and inclined, and to go deep enough to reach firm strata below the level of the bottom of the canal.
2. To "spring" the bottom of the holes by a charge of dynamite, making an enlarged or pear-shaped cavity in the firm stratum which will provide space for an anchorage of the reinforcement.
3. To place steel rods in the inclined holes.
4. To force cement grouting into the holes under a pressure of from 750 to 1000 lb. per square inch, so that the cement will penetrate all the joints and fissures, bind the rock together, and form an enlarged anchorage.

Mr. Rice believes that the vertical holes, when filled with concrete and reinforced with steel bars, would have all the advantages of deep-seated, massive piles, affording a stable foundation for any retaining wall or cap placed upon them. The inclined holes would act as diagonals or tension members. The combination of vertical and inclined concrete posts and tie bars with a concrete capping would make a dam or retaining wall of triangular cross-section which, if seated in solid-rock formation, should have great strength against lateral pressure.

The size of the rods in the holes should be proportioned to the probable stress as far as it can be estimated. They should have nuts and washers or be upset at each end.

It is also suggested that many of the ordinary retaining walls as now built for the retention of lesser slides or to retain earth embankments could be constructed relatively lighter by the use of lateral or diagonal tie rods instead of relying upon the massiveness of the structure to prevent overturning.

In connection with the piles Mr. Rice favors the adoption of other measures—first, drainage of the slopes; second, subdivision of the slopes from which the slides are liable to come, and third, interposition of what may be termed an underground dam to prevent circulation of water from the canal by wave action or "backwash." While admitting that the cost of such a plan would be considerable, Mr. Rice is of the opinion that the cost of repairing damage to an engineering work by an extensive land slide would be vastly greater.

Water Meters are to be installed in the city of Madrid, according to a recent consular report.

Expansion and Contraction Measurement of Concrete Roadways

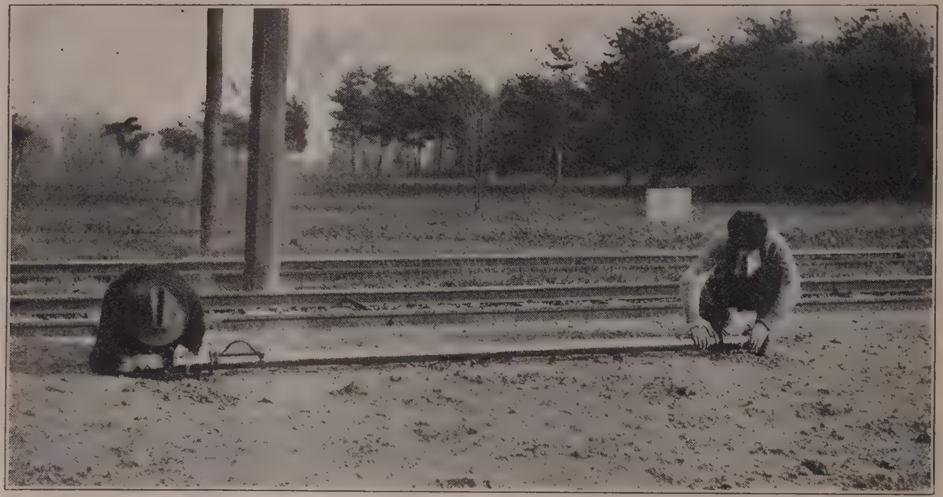
By A. T. Goldbeck, Testing Engineer, Office of Public Roads

In connection with the experimental concrete roadway constructed by the U. S. Office of Public Roads at Chevy Chase, Maryland, and described in the Engineering Record of June 28, page 719, a set of observations is being taken on the change in length of the concrete. Laboratory experiments indicate that change in moisture content has much to do with the dimensional changes of concrete construction. In fact when a reasonably rich mixture of concrete has reached a thoroughly dry condition the change in length from its condition one day after pouring amounts to at least as much as would be caused by a fall in temperature of 100 deg. Fahr. It is not expected, however, that the concrete in the roadway will be affected by change in moisture content to any such degree as this, owing to its protection from a thorough drying out by the moist underlying subsoil.

It is hoped that by accurately measuring the change in length of the concrete roadway, due both to temperature and moisture changes, data of practical value will be obtained to permit of more efficient spacing of the so-called expansion joints.

In the Chevy Chase experimental road measurements are being taken over sections of plain concrete with gravel, limestone and trap rock aggregates, over sections having bituminous coatings, and over sections of oil-mixed Portland-cement concrete. For this purpose brass plugs 5 in. in length and ¾ in. in diameter were embedded in the concrete just before the final floating and were spaced in double rows 5 ft. from the sides of the road, one row having a 10-ft. spacing and the other a 50-ft. spacing. The tops of the plugs are drilled with a 1/16-in. hole and are protected by means of a brass collar into which at first a rubber stopper was inserted. The rubber proved to be a very attractive plaything for the children of the neighborhood, so putty was ultimately substituted.

Measurements are taken from plug to plug by means of a 10-ft. strain gage. This instrument, which was designed to give an accuracy of one-thousandth of an inch in 10 ft., consists of two ½-in. tubes, one of brass and the other of steel, inclosed in a double-brass casing, the diameter of the outer casing being 3 in. and that of the inner casing 2 in. Castings containing hardened-steel points support the ends of the instrument, one casting being fitted with two micrometer heads and the other with two hardened-steel plugs with flat ends. As shown in the illustration, readings are taken by resting the two points of the instrument in the 1/16-in. holes drilled in the embedded brass plugs. The double tubes, one of steel and the other of brass, are used to take care of temperature changes, as readings are taken at different seasons of the year. The instrument has been carefully calibrated by reading on a steel gage bar immersed in water at a constant temperature. Steam was passed through the inner casing and readings taken upon micrometers, and finally cold air was passed in the same manner until the bars had both been reduced to the same temperature, when micrometer readings were again taken. From the result of this calibration means are at hand for judging of the average temperature of the tubes from their measured difference in length and a very accurate method is furnished of reducing the micrometer readings on the road to what they would be if the temperature were to remain constant.



Strain Gage in Use Measuring Expansion or Contraction in Concrete Road

Excavating Costs on City Work

The following figures are reported by the Aberthaw Construction Company, of Boston, in connection with the excavation of 6976 cu. yd. of earth on a piece of work in Boston. The conditions were favorable; there were no rocks and the soil was fairly loose. A ⅔-yd. Thew steam shovel was used, and the carting was done with 2-yd. end-dump wagons, the hauls averaging more than a mile. The total cost per cubic yard was $0.66⅚, distributed as follows:

EXCAVATING	
Shovel, 25 days	$300.00
1 Engineer, 25 days at $37 per week	154.00
1 Fireman, 25 days at $18 per week	75.00
1 Foreman	83.00
2 Laborers trimming around shovel, 25 days at $2	100.00
Other labor preparatory to and during shoveling, 411 men at $2, estimated 10 per cent at dump	740.00
Miscellaneous laborers	37.00
Total	$1,489.00
Cost per cubic yard, exclusive of runway	0.21⅓
TEAMING AND DUMPING	
481 Teams at $6	$2,886.00
Foreman	176.00
Laborers	82.00
Lumber for runways	31.00
Total	$3,175.00
Cost per cubic yard	0.45½

Tunneling the Red River to convey water into Winnipeg, Canada, is proposed in City Engineer Ruttan's report on the proposed new water supply. The tunnel, it is reported, would be large enough to carry four 48-in. pipes.

Constituent Principles of Highway Maintenance

Analytical Discussion of the Economics of Highway Administration

Highway maintenance is an engineering problem as important as highway construction, but the failure to recognize its significance in the past has led many road officials to subordinate it to the execution of new work. Given only secondary consideration, inefficient administration systems have developed, and in consequence repair and maintenance have suffered greatly. Some of the defects in the highway organizations now in vogue, with possible remedies, have been pointed out by Dr. L. I. Hewes, chief of economics and maintenance, in a chapter on road management in a recent bulletin issued by the U. S. Office of Public Roads. The salient points developed in the chapter are presented in this article.

Viewing public roads as a whole, the defects of small administrative units are conspicuous. The number of men who have more or less authority and personal direction over road matters in some sections of the country is extraordinary. There are at least 150,000 such road officials in this country. The term of office of these men is but a year or two, and rotation in the office tends to be the rule.

It would seem that just where the stimulus of effective organization is most needed it is absent. The only successful attempts at systematic repair and maintenance on record are those which have been managed with skilled and strong central control. Almost without exception, those states which have undertaken state aid in any form for road building have, in the annual reports, reiterated the necessity of removing the responsibility of repair and maintenance of such roads from local authorities. In a number of states this change has been made, and the results have been an immediate improvement.

Training and Preparation

A fundamental difficulty with the organization of road systems which must handle repair and maintenance appears to be the failure to recognize that road work is a trade which requires training. Training for road work must necessarily be obtained at the expense of the community. As a rule, road officials are not in office long enough to mature their experience, and there is a constant economic waste of road funds.

Repair and maintenance operations upon all public roads necessarily extend over a period of years. In order to secure effective execution of such operations, a comprehensive plan for several years is necessary. The work for each season must be carefully laid out as far in advance as possible. Where maintenance work has been seriously undertaken under such a system it has responded with gratifying results.

Whatever the civil subdivision may be which constitutes the administrative road unit, a good road map showing all the various classes of roads is desirable. Realizing this, the state of New York has undertaken the preparation of a comprehensive atlas of all its roads. The roads are drawn uniformly ¼ in. in width at a scale of 1 mile to 3 in., which allows all culverts and bridges to be shown. The Ohio State Highway Department has issued a bulletin giving maps of all roads in the state by counties. In this also the scale is 1 mile to 3 in.

It has been found that the best results follow in an administrative district where the mileage of roads is sufficient to warrant the continuous employment of a man who is either a highway engineer or a competent roadbuilder, whose interest is primarily in road work, and who has actual charge of road matters in his district. Where such a man is employed from year to year he can select competent men for road work, and he is able to plan with confidence systematic improvements which must wait for successive annual appropriations.

Good business organization in road work demands an adequate bookkeeping system from which unit prices for various classes of work can be easily derived. Too frequently road accounting presents an accurate list of men to whom money has been paid for material or labor, but from which no estimate of the cost of future repair and maintenance work can be established.

Large jobs of repair are usually most advantageously handled by contract. Contract work must, however, be done under competent inspection and with proper plans, profile, and written specifications. Where road work is in continuous charge of one competent man it is possible for him to gain information from time to time which fits him to draw up proper specifications, avoid the repetition of mistakes, and benefit by the experience of other highway engineers. With a rotation of road officials there is little incentive for a man to familiarize himself with the best practice. He is not interested primarily in road matters and can not be expected to educate himself by reading road journals or attending road gatherings.

Value of Traffic Census

It will be more and more necessary in the future to study the service of various roads by accurate traffic censuses. From the investigations that have already been made it appears that for any civil subdivision a relatively small percentage of all the roads carry nearly all the travel. In France a traffic unit called the "collar" is used. The "collar" is a single horse harnessed to a vehicle, and all other traffic is reduced to "collars," including automobile traffic. The "collar" has not been adopted in the United States as a traffic unit. It is unfortunate, moreover, that no agreement exists among road men at present as to the detailed method of measuring traffic. Traffic censuses were taken in Illinois in 1906-7, in New York in 1909, and in Massachusetts in 1909 and 1912. These censuses counted the travel, but no common unit is yet available for reducing such traffic data; moreover, the useful tonnage is a most important item from an economic standpoint, and it is seldom counted.

It is well established that an improved road draws to itself increased traffic. To determine the future use of roads, it will be necessary not only to know the travel passing over the road before improvement, but also to know the increase of travel which is likely to be diverted to the road when it becomes improved. It is undeniable that travel upon roads in general is rapidly increasing numerically in tonnage and in mileage of travel radius. Preliminary study is clearly necessary, therefore, to enable road men properly to relate the first construction costs to probable maintenance charges. There should be an ample "factor of safety" in road design to allow for increased service.

Under a competent and continuous administration there are many details which can be worked out for road betterment which are otherwise neglected. It is necessary for economy to have the location of deposits of all road material within a road district placed on the road map and the quality of each deposit carefully recorded. The care of all road machinery should be in competent hands, and it should be housed and ready for use when the season commences.

A gradual improvement in the grades of more important roads can be undertaken with an established profile toward which some work is directed each year. It is quite probable that the prevailing lack of permanent culverts and bridges on highways is partly due to the unwillingness of short-term road officials to spend a considerable amount of money in one place. Under a continuous administration some permanent culvert or bridge work may be undertaken from time to time along a plan which contemplates the final improvement of all such structures.

Road Patrols

It is probable that the continuous employment of road patrols will be too expensive for a large part of our road mileage for some time to come. It is equally true, however, that on many miles of road the presence of a road patrol at a cost of from $60 to $75 per month will be economy. It has been repeatedly observed that the work of such roadmen in preventing water breaks and wash from rainstorms and thaws at the right time has in itself justified their salaries. A continuous maintenance gang of foreman and eight or ten men, with suitable equipment, is a practical and economical maintenance force for county-road systems, aggregating 100 miles or more, where a patrol system can not be economically established. Whatever system of road labor is adopted, the work should be organized early in the year and experienced men developed and retained as far as possible. The foreman of a repair gang on road work should have sufficient knowledge and experience to justify spending his entire time in supervising and planning the work without attempting to labor with his men. The element of thoroughness in details, such as complete cleaning of mud holes, sufficient material, swift repair of water breaks, etc., can not be overemphasized. There is always enough necessary planning and supervision to keep a good road foreman occupied.

The supply of road material for repair and maintenance operations should be at frequent intervals along all roads—for example, there should be sufficient broken stone of both sizes and screenings at hand on all macadam roads, and the quantity should be known. With the increased use of bituminous material it is necessary also to supply at convenient intervals stores of such material, and men working on the roads must be furnished with necessary small tools, including tar kettles, heating apparatus, pouring pots, and stiff pushbrooms.

European Practice

On the Continent of Europe and in England, where road repair and maintenance have been conspicuously successful, it has been the practice to issue printed instructions covering the smallest detail to all men engaged in the work. It is also the plan to require reports of work done and of quantities of material used at frequent intervals, and sometimes daily. Roads are frequently inspected and accurate estimates of all quantities of work are made from year to year.

The superiority of the French road system is not due to any extraordinary natural conditions or advantages but to the efficiency of the administrative organization. The basis of the administrative system is the publicly maintained Ecole des Ponts et Chaussées, where the road engineers and officials receive their technical training. A regularly recruited corps of trained and experienced men is thus constantly in charge of all the important roads. The department of the Ponts et Chaussées constitutes also a centralized source for information concerning the roads of the entire country.

For the purpose of road maintenance and construction the organization is as follows: (1) Inspectors-general of bridges and highways; (2) chief engineers, charged with the work of a "département"; (3) ordinary engineers and under engineers, charged with an "arrondissement"; (4) principal and ordinary conductors, charged with a subdivision; and (5) cantonniers, each having from 4 to 7 km. (2.48 to 4.05 miles) of highway under his immediate supervision.

Long-Term Bond Issues

Repair and maintenance have not been given sufficient consideration in planning road finances. It is becoming yearly more common for local authorities to issue bonds for road construction. During 1912 nearly $29,000,000 in bonds were issued by counties and road districts in various parts of this country for road construction. It is not uncommon to find such bond issues planned with no provision whatever for a repair and maintenance fund. No road can last thirty years without repairs, yet thirty-year bonds are repeatedly issued for road improvement. Many such bonds are commonly issued and the proceeds are expended without adequate supervision and under weak administrative systems. Every bond issue should be accompanied by a direct tax providing sufficient revenue for the upkeep of the roads with a good margin of safety, and the term of the bond should in most cases be shortened. Without doubt a serial bond is to be preferred to the form of retirement by a sinking fund. Serial bonds may be arranged so that the annual tax for interest and retirement is constant. With a serial bond there is a large percentage of the road actually paid for before it is worn out, even with long-term issues.

There is apparent contradiction in the cost figures for repair and maintenance exhibited by expenditures on roads of a given class as a whole and the figures obtained by analysis of the cost of necessary operations on a given type of road. On a 15-ft. bituminous-macadam road an annual charge of $700 a mile is nearly 8 cents per square yard. Although the cost of repair and maintenance in a number of states has recently averaged above $700 per mile, the annual cost of necessary operations for repair and maintenance by any given method is, on an average, considerably less than 8 cents per square yard.

The apparent contradiction is partly due to the excessive accumulation of resurfacing charges. Resurfacing charges have recently risen because of the particular phase of average-life period reached by a large mileage of state-aid roads and because of the emergency created by the new traffic, and especially because of the combination of the two causes. Insofar as surface treatment is absolute maintenance this present prevalent method of maintenance includes the former annual resurfacing charges which ordinary macadam roads required, but which for a number of years did not appear in the repair and maintenance figures. The present years are, therefore, bearing not only accumulated past resurfacing charges, but are now carrying an increment of annual cost directed toward the increased life of the new road surface.

Assuming the cost of bituminous resurfacing at 72 cents per square yard; the annual maintenance, including necessary surface treatment, 4 cents; and the total annual charge for ordinary macadam resurfacing and maintenance, 5.9 cents; then if it is desired to find the number of years, n, a road reconstructed with bituminous surface must wear, without resurfacing but with regular surface treatment, in order that the total annual cost shall be the same as for ordinary macadam, there results from the above figures $(72 + 4n) \div n = 5.9$, whence $n = 37.9$ years, nearly.

It is possible that considerable resurfacing of bituminous-bound macadam roads will ultimately be necessary, and in this case there will be a rise in repair costs when the life period is reached. Maintenance of roads subject to automobile traffic tends more and more to become absolute maintenance. Not only does automobile traffic become increasingly destructive to a road which is once allowed to ravel, but the reaction of road surfaces upon automobile tires is now a matter of much importance.

Repair and Maintenance Expenditures in Connecticut, Massachusetts, New Jersey, New York and Rhode Island

Year	Miles	Appropriations and expenditures*	Rate per mile
1905	†668	†$60,777	$100
1906	‡2,125	‡624,696	294
1907	3,303	1,024,096	310
1908	3,906	1,441,502	369
1909	5,161	2,880,272	558
1910	5,572	4,336,201	778
1911	6,183	4,491,718	§726
1912	7,300	5,945,084	814
Average for eight years	.....	....	608

*Includes town and county expenditures and available automobile revenue.

†Connecticut, New Jersey, and New York not included.

‡Connecticut not included.

§New York appropriation late; repair and maintenance work not completed.

Increased knowledge is needed of the actual relations between first cost and interest and of the life, service, and maintenance cost of the road. In future investigations for determining the type of road to be built it will be necessary to provide for large increases in traffic and carefully to balance the advantages of long-lived road surfaces, such as concrete and brick, with low maintenance costs, against the lower-cost road surface, with little or no factor of safety and immediate and high maintenance costs.

A Concrete Bridge of four 23-ft. spans, resting on concrete piles 30 ft. in length, that had been driven through fine sand and silt with the aid of two 1-in. jets, was damaged during a typhoon which scoured out the channel to such an extent that bent No. 2 settled 4 in. and bent No. 3 settled slightly over 3 ft., but the damage was repaired without reconstructing the bridge, according to the "Quarterly Bulletin" of the Philippine Bureau of Public Works. Large stones and sand were used to refill part of the stream about the two bents that had settled. Four 25-ton screwjacks were placed on the larger stones and the bridge floor slabs raised until they were brought up to their original elevation. The old caps were then built up with concrete and after forty-eight hours were allowed to carry the floor loads. Heavy traction engines have run over this bridge since, causing absolutely no settlement; the skin friction on the piles due to the added weight of sand and stone at their base seemingly prevented any further movement of the bridge structure.

Rules Governing the Presentation of Papers

In accord with the motion passed at the annual meeting of the society, "that a committee of five be appointed to consider an improvement in the methods of the presentation of papers before this society," the board of directors of the American Society of Civil Engineers has given careful consideration to the matter referred to it.

The board has inquired into the current practice of other societies, invited individual suggestions, and has made the following recommendations, largely in accord with past practice, but embodying some new features, and outlining a course of procedure for the convenience of authors and of the publication committee:

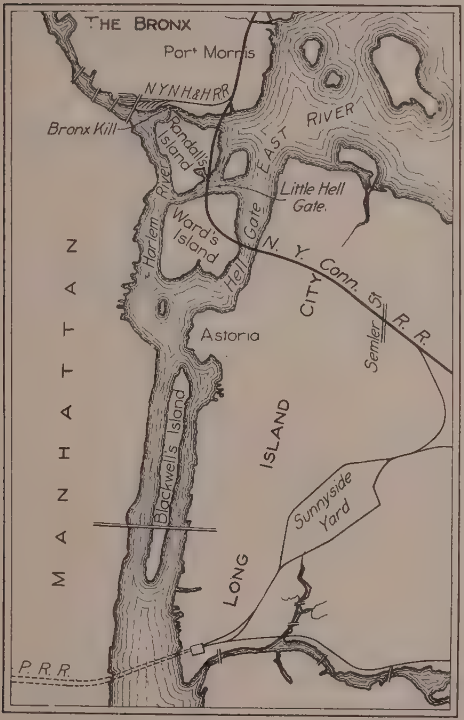
1. That every author be required to submit with his paper a summary giving the objects of the paper, a brief digest of its contents, and a concise statement of its conclusions, to be read at the meeting, so that members who have not been able to read the paper in advance of the meeting may be able to follow and take part in the discussion of it.
2. That the author of each paper approved for discussion be urged to present his paper in person, or to give at least thirty days' notice to the secretary that he will not be able to do so, and to suggest the name of some member to present it for him who is especially fitted to do so. In default of such suggestion by the author the secretary must either find some such substitute or present the paper himself.
3. That the author be requested to submit with his paper a list of members of the society especially qualified to discuss his paper, and that the secretary call the paper particularly to the attention of these members and others locally known to him as likely to be interested in it, urging them to be present at the meeting at which the paper is to be presented and to join in its oral discussion.
4. That the secretary, in calling the attention of local members to the paper, give, so far as practicable, the names of men who have promised to discuss the paper upon the evening of its presentation.
5. That subjects of similar nature be grouped, for discussion at the same meeting, when possible.
6. That papers lending themselves to oral discussion be given preference for presentation at the semi-monthly meetings, and that papers better suited to written discussion be printed in the "Proceedings," without oral discussion, so far as practicable.
7. That oral discussion be encouraged in every way possible.
8. That the printing of his discussion be optional with the speaker.
9. That the use of lantern slides for illustrating papers and discussions be encouraged, and that, when considered advisable by the publication committee, the society have slides made, at its expense, from photographs or plans furnished by the author.

Forests as Investments, in connection with the general care of watersheds, were discussed by Mr. E. R. Peck in a paper presented at the annual meeting of the American Waterworks Association. The forester of the Hartford Water Department has estimated that an area reforested with white pine should net 4 per cent compound interest on the investment in 50 years. This calculation is based on a cost of $7 per acre for planting and a land value of $12 per acre, proper allowance being made for care and taxes.

Bridges, Viaducts and Embankment Work of the New York Connecting Railroad

Principal Structure Is the Four-Track 1000-Foot Steel Arch Span across Hell Gate

The four-track New York Connecting Railroad, about 10 miles long, joins the terminus of the New York, New Haven & Hartford Railroad in the Borough of the Bronx, New York City, with the Pennsylvania Railroad system at the Brooklyn Borough line on Long Island and forms a link in the all-rail route from New England and Canada to the south, west and southwest. Two tracks will be devoted to the passenger traffic, which will be accommodated by the present Pennsylvania tunnels under the East and North Rivers and Manhattan Island, while the other two will be used for freight and will connect with the Bay Ridge ferry, which runs to the Greenville, N. J., yard of the Pennsylvania Railroad. The work is unusual on account of the magnitude, variety and special features of construction, and the design and dimensions of some of the structures, chief of which is the Hell Gate arch, are of much greater span and capacity than that of any similar bridge.



Location of Bridges and Viaducts

The estimated total cost of the connecting-railroad construction is about $25,000,000, and it is hoped that it will be ready for operation in the summer of 1915. The southern division of the work, about 6½ miles long, includes a tunnel about 3500 ft. long to East New York, several overhead street bridges and a considerable amount of grading. The East River Bridge division, about 3½ miles long, extends from Port Morris to Stemler Street, Long Island City, and will require about 90,000 tons of steel and 450,000 cu. yd. of concrete. The great towers of the main span, the high concrete viaduct piers and some of the retaining walls are of unusual dimensions and design. Mr. Gustav Lindenthal is the chief engineer and designer of all the structures and is in charge of their construction, which was commenced in July, 1912.

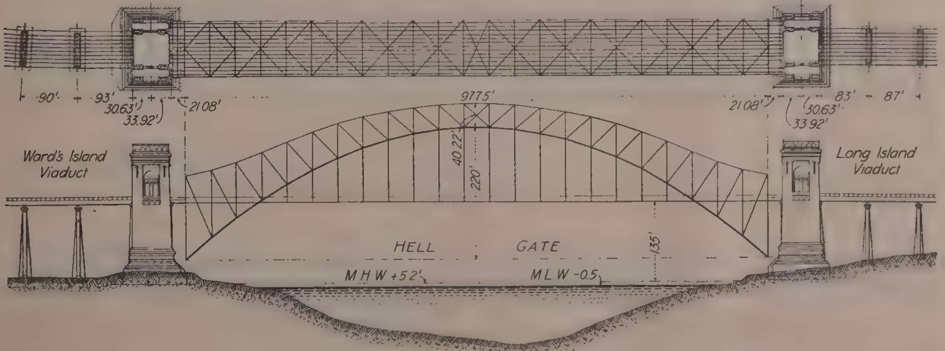
HELL GATE ARCH SPAN

The steel arch span will have two trusses 977.5 ft. long from center to center of skewback bearings, supported on towers 1087.5 ft. apart on centers. The 100 x 140-ft. towers are located on shore 18 ft. above the high-water line and are 250 ft. in extreme height above mean-low-water level. At the Long Island end the foundations are carried to solid rock at a depth of about 15 ft. below the surface, and at the Wards Island end the footings are supported on reinforced-concrete caissons, to be sunk by open excavation and by pneumatic-caisson work, if necessary, through top soil, boulders and sand to ledge rock at a probable depth of about 140 ft. below mean-low tide.

The main trusses, 60 ft. apart, are 145 ft. deep at the skewback and 45 ft. at the crown, and are divided into twenty-three panels each 42½ ft. long. They support a single roadway platform 93 ft. wide with four tracks between the trusses and two sidewalks on cantilever extensions beyond the trusses. The trusses rise to a height of 300 ft. above the water, while the roadway has a clearance of 135 ft. above mean high water and is suspended from the lower chords of the seventeen center panels and passes through the trusses for three panels at each end of the span. The trusses are proportioned to carry on each track two 860,000-lb. locomotives followed by a trainload of 6000 lb. per linear foot.

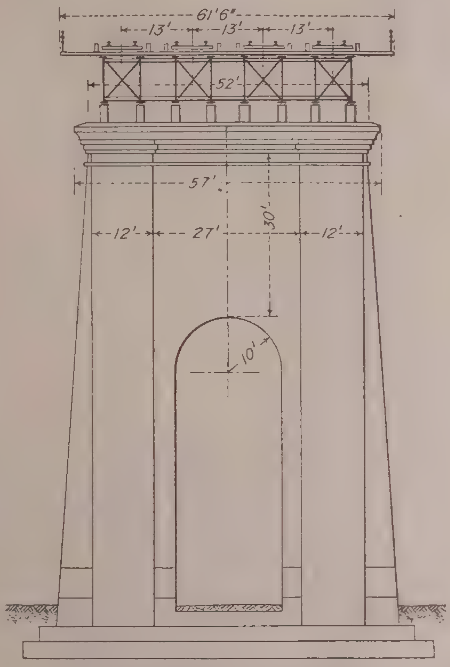
LITTLE HELL GATE AND BRONX KILL BRIDGES

Little Hell Gate channel, which connects the East and Harlem Rivers and separates Wards and Randalls Islands, is crossed by a four-span bridge with two lines of bowstring trusses 60 ft. deep, 62 ft. apart on centers and 55 ft. in the clear above mean-low water. The end abutments consist of two piers united by diaphragms transverse to the bridge axis. They are seated on a single continuous footing, I-shape in plan, and are surmounted by rectangular towers on both sides of the tracks. The intermediate piers consist of pairs of cylinders 24½ ft. in diameter at the base and about 100 ft. high from the surface of the water to the bridge seats.



Hell Gate Arch Span with Very Deep Caisson Foundation

The main trusses of the Bronx Kill Bridge will be installed as fixed spans, to which counterweights and operating mechanism may later be added to transform them to bascule leaves. Each pier has two shafts that are connected by transverse diaphragms at right angles to the bridge axis, although the channel is oblique to the axis. The abutments each consist of four piers connected by longitudinal and transverse concrete walls forming an inclosure suitable for the installation of the counterweights and operating mechanism for the bascule leaves.



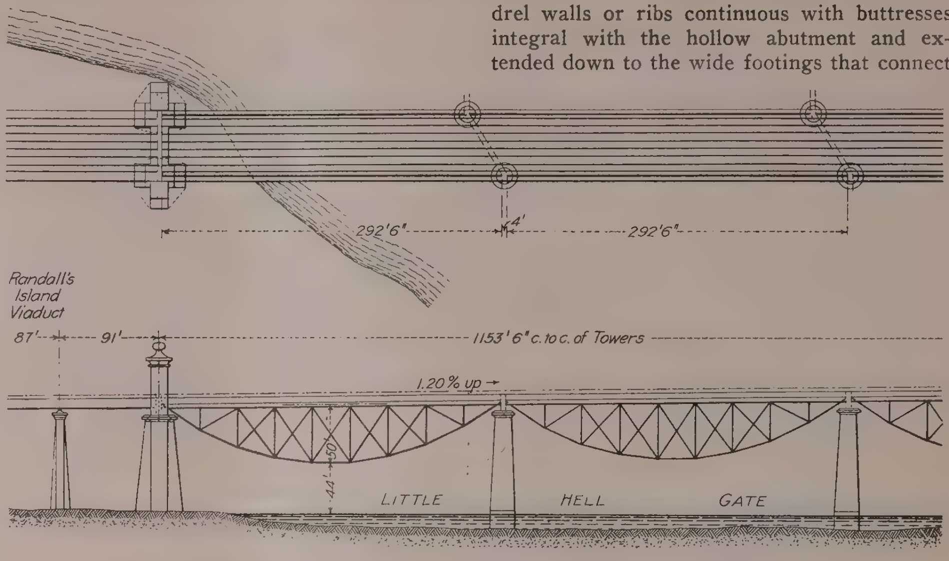
Wards Island Viaduct Pier

VIADUCTS

Through the whole of the East River Bridge division the four tracks are carried at a height of from about 20 to 135 ft. above the surface of the ground and between the bridges are supported on viaducts of two different types. Across Randalls and Wards Island and in the contiguous portions of the Bronx and Long Island the viaducts have plate-girder superstructures carried on concrete piers. At both

Pier of Bronx Viaduct

ends of the division the viaducts are virtually high causeways consisting of selected and especially prepared earthfill retained between high longitudinal side walls and the abutments of short spans carrying the tracks over intersecting low-grade streets. The overhead crossings are made with concrete arches, plate-girder spans or lattice-girder spans, concrete piers and abutments. The steel spans are of moderate dimensions and ordinary construction, with two lines of girders for each track.



One End of Four-Span Bridge across Little Hell Gate

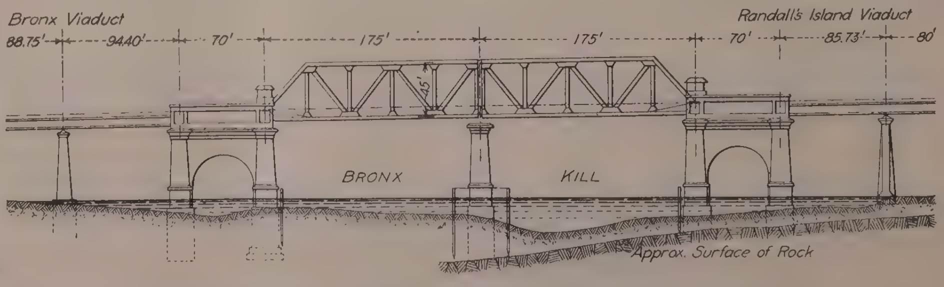
From its terminus at the New York, New Haven & Hartford Railroad station to East 138th Street the two double tracks of the Bronx viaduct are carried on earthfills 31.25 ft. apart in the clear, which are made between concrete retaining walls built on a lower embankment about 160 ft. wide at the bottom and 28 ft. in average height. One side of the embankment is sloped and the other side is retained by a buttressed concrete wall with a pile foundation. On top of this embankment, between the two pairs of retaining walls and outside of one pair, there are two pairs of low-level tracks of the New York, New Haven & Hartford Railroad, making a total of eight lines in this section of the work. The remainder of this viaduct consists of plate-girder spans on concrete piers with pairs of cylinder caisson foundations. Where the low-level tracks diverge from the alignment of the high-level tracks the latter converge to their normal spacing and the construction changes from two double-track viaducts to a single four-track viaduct extending to the Bronx River Bridge. The same type of structure is extended across Randalls Island to Little Hell Gate Bridge, with the pier foundations built in open pits excavated from 2 to 25 ft. to rock. Wards Island viaduct connecting the Hell Gate and Little Hell Gate Bridges and the Long Island viaduct are similar to the Randalls Island viaduct.

Piers with Concrete Footings for Spans over Streets, Eastern Viaduct

Structures on East River Bridge Division of New York Connecting Railroad

Name of structure	Type	Spans	Length of spans, ft.	Total length, ft.	Foundations	Height above ground or water, ft.
Hell Gate Bridge	Steel arch	1	1000	1106.6	Open pit and deep caissons	135
Little Hell Gate Bridge	Steel deck truss	4	292½	1153½	Caissons	94
Bronx Kill Bridge	Bascule	4	70 and 175	490	Caissons	60
Bronx Viaduct	Retained fill and plate girder spans	..	64 to 112	4200	Caissons, piles and open pits	20 to 65
Randalls Island Viaduct	Plate girder spans	24	80 to 87	1960	Open pits	65 to 90
Wards Island Viaduct	Plate girder spans	30	82 to 93	2650	Open pits	105 to 130
Long Island Viaduct	Chiefly plate girder spans	..	72 to 90	2868	Open pits	60 to 120
Eastern Viaduct	Retained fill, concrete arches and lattice girder spans	..	60 to 126	3480	Open pits	35 to 60

The Eastern viaduct extends from Lawrence Street to Sumler Avenue, connecting the Long Island viaduct with the southern division of the railroad at a point where the tracks of the latter are carried on an embankment with sloping sides, which consists mainly of a fill inclosed between concreted walls except in street crossings, all of which are oblique to the axis of the railroad. The concrete arch spans are from 60 to 75 ft. long and are skewed; but the abutments of the steel spans are made square, and the length of the span is increased sufficiently to afford clearance for the full-width streets.



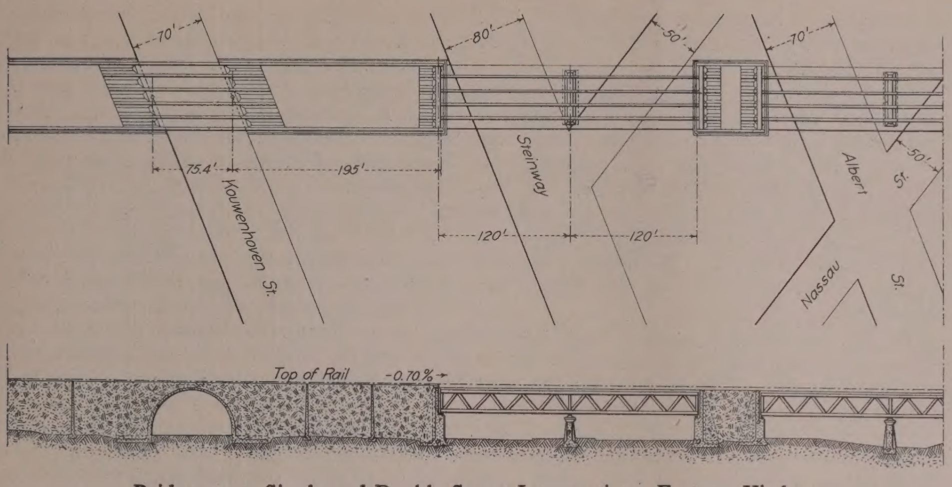
Bronx Kill Bascule Bridge, Temporarily Installed as Fixed Spans

The full-centered arch spans have solid continuous rings carrying six longitudinal spandrel walls or ribs continuous with buttresses integral with the hollow abutment and extended down to the wide footings that connect the transverse walls and receive a heavy surcharge from the fill. The abutments for the steel spans serve also as retaining walls for the ends of the fills between streets and are of similar buttressed construction, with very wide and shallow continuous footings.

Thin High Retaining Walls

The fill on which the tracks are supported is retained between vertical longitudinal side walls of unusual proportions. They are spaced about 60 ft. apart in the clear and their heights vary from about 35 to 60 ft. The outer face is battered 1:40 and the inner face is vertical. The thickness at the top is 3 ft. 9 in. The footings are generally 4 to 6 ft. below the surface of the ground on a hard stratum of sand and gravel. At intervals of 60 or 70 ft. the walls are connected by vertical transverse walls reinforced by rods extending into the longitudinal walls, and are connected to the latter by heavy vertical concrete fillets tending to serve as horizontal braces.

The longitudinal walls are reinforced by a system of vertical and horizontal 8-in. channels 10 ft. apart in both directions, which are bolted together at intersections where they are pierced to receive the screw ends of 1½-in. horizontal tie rods extending across the full width of the structure and connecting the longitudinal walls. The horizontal rods are made in three sections, with the middle section connected to the end sections by sleeve nuts just inside the wall masonry, which allow the end pieces to be built in with the walls and the center sections to be added when the filling is put in place and the rods are inclosed by solid masses of protecting concrete. The fill is to be of selected material, thoroughly rammed or otherwise compacted in shallow crowned layers. It will be drained through batters of loose stone leading the flow to weep holes. This portion of the viaduct thus consists sub-



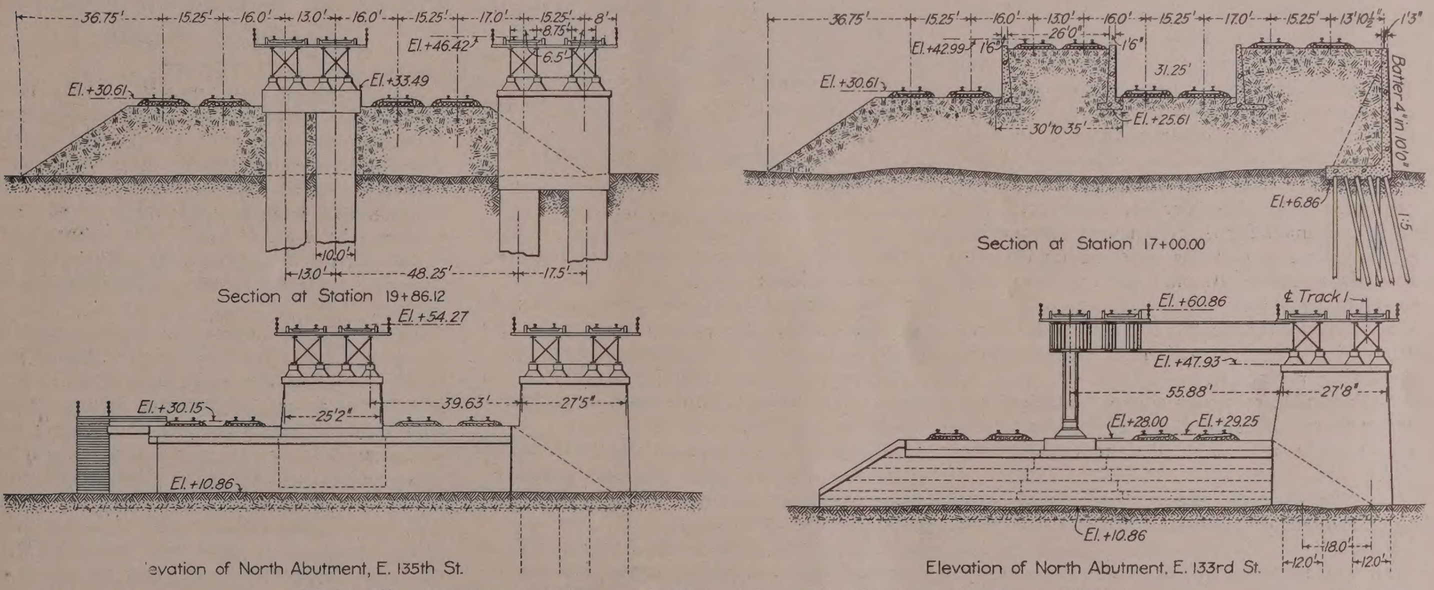
Bridges over Single and Double Street Intersections, Eastern Viaduct

stantially of a row of large, thin concrete boxes filled with earth on which the tracks are laid.

Work on the East River division was commenced in July, 1912, has been vigorously prosecuted and is now in progress on all parts of the lines.

The design and construction are under the direct supervision of Mr. O. H. Ammann, assistant chief engineer, and Mr. H. W. Hudson, engineer of foundations and masonry.

The contracts for the fabrication and erection of the 19,000-ton Hell Gate arch span and for the Wards and Long Island viaduct have been awarded to the American Bridge Company and that for the other viaducts and truss spans has been awarded to the McClintic-Marshall Construction Company. The contracts for the masonry and foundations commencing at Port Morris have been awarded to Arthur McMullen, to the Patrick Ryan Construction Company, Inc., to the Snare & Triest Company and to the T. A. Gillespie Company. These contracts include the substructures and foundations of all the bridge and viaduct spans for the improvement.



Solid Fill with Buttressed Retaining Walls, Piers and Abutments for Bronx Viaduct

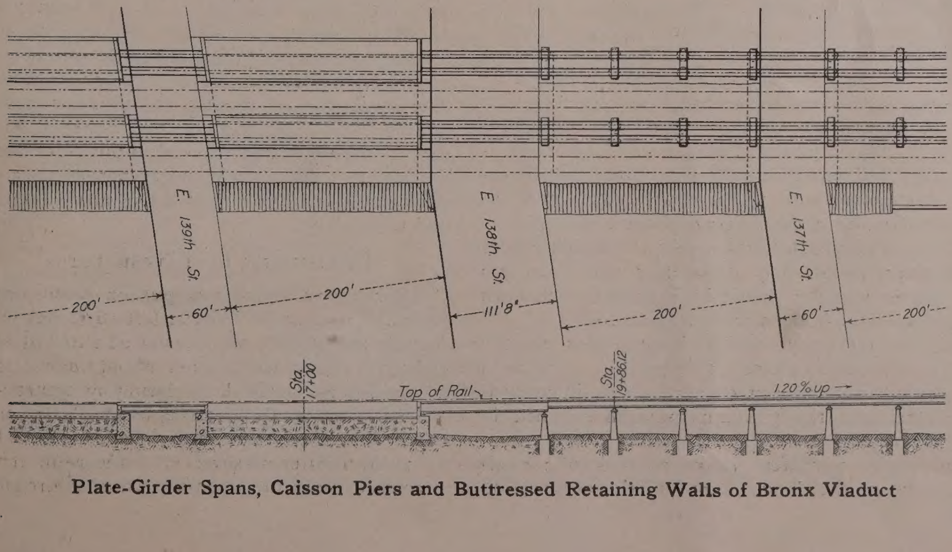


Plate-Girder Spans, Caisson Piers and Buttressed Retaining Walls of Bronx Viaduct

Controlling Cherry Creek Floods, Denver

Large regulating reservoirs are recommended by the Cherry Creek Flood Commission for the control of the recurring floods in Denver, Col., caused by periodical high water in Cherry Creek, the Platte River and its tributaries. In a typewritten report of 225 pages, accompanied by numerous maps and photographs, the commission of engineers, Messrs. A. Lincoln Fellows, J. B. Hunter and C. A. Trease, outlines and discusses fifteen plans. The plans include all the suggestions which were proposed after the flood of July 14, 1912, described in the Engineering Record of July 20, page 68, and July 27, page 92. The first four plans contemplate using the present channel, either as now, in part, constructed, or with paving; increasing the height of the walls or the width of the channel, or both, or by the construction of reservoirs or other means of regulation. Plans 5, 6 and 7 propose the diversion of flood waters from Cherry Creek to the South Platte River by another route than the present channel. Plans 8 and 9 contemplate the diversion of these flood waters for irrigation purposes through the construction of storage reservoirs located at points more or less distant from the Cherry Creek channel. Plans 10 and 11 provide for the construction of a number of reservoirs or regulating dams along Cherry Creek and its tributaries. Plan 12 provides for both regulation and the subsequent construction of a concrete conduit to be used as a sewer. Plans 13, 14 and 15 contemplate the construction of a reservoir of greater or less capacity practically at the eastern city boundary.

After studying the different plans the commission has come to the conclusion that the best method of controlling the situation and eliminating the dangers to the greatest possible extent is by the construction of a single large reservoir rather than a number of small ones. Plans have been adopted for a reservoir with a capacity of approximately 12,000 acre-ft., necessitating a dam with a spillway approximately 42 ft. above the bottom of the outlet chambers, the spillway occupying approximately 200 ft. of the length of the dam. Beyond the spillway and extending the entire length of the dam, with the exception of the spillway, would be an embankment of earth with a crest elevation 10 ft. above the crest of the spillway. This dam would be so constructed as to permit of its being increased in height, should this appear desirable. Such a dam is estimated to cost $500,000, while an equal sum would be required for land.

Conclusions

As a result of its study the commission came to the following conclusions:

1. Conditions on Cherry Creek are such that floods as great as those that have already occurred appear to be certain, while very much larger floods may be expected.

2. A flood with a maximum discharge of 60,000 cu. ft. per second lasting for a short time is considered not only possible but even probable.

3. Damages resulting from great floods of equal volume must necessarily increase with the growth of the city unless proper control is provided.

4. Direct losses in the past resulting from floods have aggregated hundreds of thousands of dollars, with a loss of some lives.

5. Losses from floods in the future cannot be estimated even approximately, but are certain to amount to millions of dollars and the loss of many lives if remedial plans are not adopted.

6. Flood losses in other portions of the valley of the South Platte and Cherry Creek districts, both of vital importance to Denver, will become more and more serious as property becomes more valuable.

7. Relief through other methods than regulation by reservoirs is not recommended for the reasons that such methods would give local relief only, that increase in size of the present channel for diversion would prove inefficient, or else that the construction of sufficiently effective channel and walls would prove to be too costly.

8. It is entirely feasible to regulate the flood waters by the construction of one or more regulating reservoirs.

9. Favorable reservoir sites of sufficient capacity to regulate the floods of Cherry Creek exist within reasonable distances above the city limits.

10. One reservoir site of sufficient capacity and fulfilling all essential requisites has been selected.

11. The reservoir site selected is capable of furnishing all the protection required when the channel is put in good condition, as recommended.

12. If this reservoir had been constructed and the channel had been properly cleared of obstructions at the time of the flood of July 14, 1912, no damage would have resulted.

13. To supplement the construction of a regulating reservoir the channel through the city should be made efficient by the completion of the walls and removal of pile bridges and other obstructions, and such work as would be necessary to make the stream capable of carrying from 10,000 to 12,000 cu. ft. per second without endangering the city.

14. Flood prevention by storage reservoirs is possible and practicable and is recommended because (a) flood relief would benefit residents in the South Platte valley as well as in the city of Denver; (b) the regulated supply would be more easily diverted and controlled for irrigation and other beneficial uses than would be the case with unregulated flood flows; (c) public health would be safeguarded against dangers arising from the insanitary conditions caused by overflow; (d) a properly constructed regulating reservoir would appear to satisfy all conditions.

15. Regulating reservoirs have been built in other countries with such success in preventing floods that other large works of this kind are now under construction and many more are contemplated.

16. Regulation of Cherry Creek floods by regulating reservoirs has been pronounced practicable by a number of eminent engineers to whom the problem has been submitted.

17. The estimates of cost of regulating reservoirs, while of more or less preliminary nature, are believed to be conservative and show that Denver may be completely protected against floods at a cost of not more than $1,000,000.

18. The construction of the proposed regulating reservoirs and the control of the floods are urged for the following reasons: (a) Had such a reservoir been constructed at the times of the occurrence of the great floods in the history of the city, losses aggregating at least hundreds of thousands of dollars would have been saved; (b) it would insure protection against damages aggregating in the future many times the cost of the reservoir, as well as the saving of lives; (c) it would increase the value of property along the Cherry Creek valley in the city of Denver and in the lowlands along the South Platte by an amount much more than the cost of the regulating reservoirs; (d) the cost is small when the total property loss by flood damage within the next few years in all districts that would receive benefit is considered; (e) the value of the water acquired by the city would go far toward compensating for the cost of the reservoir; (f) the value of the proposed reservoir as a park site is material and should have due weight.

Recommendations

The flood commission makes the following recommendations:

1. The channel of Cherry Creek within the city limits, where not yet acquired by the city, should be acquired as soon as possible.

2. The work of walling the creek from Blake Street to its mouth should be pushed as rapidly as possible.

3. All wooden bridges on the creek should be removed as soon as practicable and replaced by bridges giving the freest and largest possible waterway.

4. The proper grades of Cherry Creek, as now established, should be recognized and the channel should be brought to that grade from Downing Street to the mouth of the creek at once, and as soon as practicable from Downing Street up the creek to the city limits.

5. The channel should be made clean and kept clean, any one responsible for placing obstructions in the creek being severely punished.

6. The Logan Street bridge should be replaced by a new bridge at once, and the Eleventh Street and Thirteenth Street bridges should be replaced as soon as practicable.

7. The creek should be walled as soon as possible from Downing Street to the city limits and the channel excavated to grade.

8. The city should acquire title to the channel of South Platte River at once, and exercise police supervision over this channel, as well as over the Cherry Creek channel.

9. The pile bridges across the South Platte River, particularly those near the Twentieth Street viaduct, should be replaced by modern steel-truss bridges without delay.

10. The city should issue bonds to the amount of $1,000,000, this amount to be used in the construction of a reservoir in accordance with the preliminary plans outlined in the report.

11. A competent board of hydraulic engineers should have charge of the preparation of the detail plans and specifications and the construction of the proposed dam, and nothing should be done in this connection that does not meet with the approval of the board.

12. A thorough study should be made of the South Platte River also, with a view to the regulation of floods on this stream and its tributaries.

Work Done and Contemplated

A considerable amount of work has already been done in repairing the Cherry Creek channel in consequence of the flood of July 14, 1912. Repairs to bridges, sidewalks, curb and gutter, electric-light standards, water pipe and sewers and the removal of weir walls total about $15,000. It is proposed to reconstruct three bridges at a cost of $14,100. The reconstruction of walls, the building of a conduit to replace the Farmers and Gardeners ditch and the Cherry Creek paving cost $58,000. Four reinforced-concrete bridges of the mushroom type have recently been completed at a acost of $68,900, while the contract for walling and excavating the lower end of the stream calls for an expenditure of $144,500, making a total of $300,500.

Piecework System in Philippine Road Construction

The American road contractor who is beset with the terror of strikes and the frailties of foreign labor and finds his weekly payroll climbing in direct proportion to the increasing inefficiency of his help will feel a bit of envy mingled with sympathy for the road superintendent of the province of Iloilo, whose work is described in the "Quarterly Bulletin" of the Bureau of Public Works of the Philippine Islands.

The Philippine authorities began in the fall of 1912 to build the Duenas-Lambunao-Viejo Road. At first the work was done by day labor just as any contractor in the States would do it. The wage paid the laborer was 50 centavos (25 cents) per day, and the labor was plentiful at that price. Such conditions savor of a contractor's millennium.

But the paths of the road superintendent were not always to be strewn with roses. As the work progressed away from the towns of Duenas and Passi, the laborers, failing to appreciate the pastoral life, became fewer and fewer. Finally, by December, only a mere handful remained.

Then it was that the piecework, or "paquiao," system, by which the laborer received a given amount per station, was installed. This system, common in our American stone quarries and timber enterprises, was to some extent familiar to the Filipino, as it had been applied to making "rice paddy" fills, but as to making earth cuts and fills in road work, under contract, the natives were densely ignorant. The intricacies of sloping and ditching were beyond their comprehension. However, as the cost of the work had reached the point where the superintendence and surcharges exceeded the actual cost of moving the dirt something had to be done.

Difficulties of Task Labor

After the work was put on a piecework basis the natives, at first, left their slopes irregular and rough, and wasted the dirt they had agreed to haul. They would not complete the ditches as specified. Being by nature suspicious, they would wrangle about the price and would not trust the engineer's figures. But the authorities persevered. Hubs were driven at each break in the cross-section of the roadbed and all excavations were marked with reference to the top of the stake. The final elevation of breaks in the fills were marked by notches on stakes of sufficient length to reach to the proposed surface. It was not sufficient to take the elevation of the top of the ground and mark the cut or fill in figures on stakes, because the stations were scarcely ever finished consecutively and discrepancies which would arise because of the unevenness of the ground and of the ignorance of the natives would produce irregularities in the roadbed.

The new system has been a success. Only enough day laborers are retained to do the stations that are too small to "paquiao." Even borrowing for fills is done by the new plan. Care is taken, however, not to allow more than one section or station of fill to be incomplete when a cut is finished. The partly completed station is finished by day labor. Under the new scheme the cost of earthwork has fallen to the original day-labor prices, and the men come from all directions, work early and late, and at times of moonlight work far into the night. In this way the best of them sometimes earn as much as 40 cents a day.

That the Filipino "taos" has many points of similarity to his American prototype may be gleaned from the road foreman's report that "a little jollying goes a long way with the men." They are also quick to seize an opportunity to skimp their work and to claim that they are making less than ordinary day wages, even though that be the munificent sum of an Irishman's two-bits.

Book Reviews

"Reinforced Concrete Wall Footings and Column Footings," by Prof. Arthur N. Talbot, has just been issued as Bulletin 67 of the Engineering Experiment Station of the University of Illinois. This bulletin gives the results of tests to destruction of a large number of full-sized reinforced-concrete wall footings and column footings. The tests give the first experimental data of the action of structural footings of this kind under conditions approximating those which exist in actual structures. The results of the tests are utilized in the discussion of formulæ and principles for the design of reinforced concrete wall footings and column footings. (Urbana, Ill., Engineering Experiment Station.)

Die Berechnung der Warmwasserheizugen. By H. Recknagel, Diplom-Ingenieur. Paper, 9½ x 13½; 71 pages; 31 figures. Munich, R. Oldenbourg. $6 net.

This book deals with the calculation of hot-water-heating installations. It contains examples of thirty-eight different installations. New formulæ have been developed for the determination of the necessary temperature of the water for different temperatures of the air. For the friction losses in the pipes the coefficients of Rielschel are employed.

Schiffsturbinen. Second Edition. By Dr. G. Bauer and O. Lasche, assisted by E. Ludwig. Cloth, 5½ x 8½; 442 pages; 254 figures and 6 inserts. Munich, R. Oldenbourg, 16 M. net.

This book is a very complete treatise on steam turbines used as motive power for ships. The first 117 pages deal with methods of calculating and dimensioning various parts of such turbines and the following 100 pages contain valuable information as to design and general arrangement. Among other subjects discussed are shafts and propellers, condensers, arrangement of turbines in ships of various types, gearing, etc. The last 30 pages contain tables useful to the designer.

Automatische Registrierwagen (Automatically Registering Scales). By O. Tauchnitz. Cloth, 6½ x 9!; 124 pages; 118 figures in the text and on inserts. Munich, R. Oldenbourg, $8 net.

The subject is divided into a general introduction, dealing with the principles and details of automatically registering scales, and two main sections. Section 1 deals with scales for weighing grain, beets, coal, flour, oil, sugar, coffee, etc., and Section 2 describes various types of scales for fluids, cement, sacked materials, etc. The book is well written and the line of thought is easy to follow. It embodies the long experience of an expert who has specialized in the design of scales. Theories are eliminated as much as possible, and the book is so clearly written that it can be readily understood even by men not technically trained.

Mechanical Drafting. By H. W. Miller, M.E. Leather, 5¼ x 7¼; 219 pages; 224 figures. Peoria, Ill., Manual Arts Press, $1.50 net.

This text is intended to be used in a regular college course and presupposes a knowledge of geometrical drawing such as is given in most high and manual training schools. The treatment of the subject is altogether unique, but thoroughly practical in every way.

Detailed instructions are given to the student as to the use of drafting instruments and materials, besides useful suggestions in regard to most of the conventions resorted to in the drafting room.

One special feature of importance in any course of this kind, but which has heretofore been neglected in other texts, is the insertion of numerous half-tone illustrations of the principal machine tools used for finishing machine parts, so that the student can design these parts with a knowledge that they can be properly finished in the shop.

Another good feature is the elimination of much copy work on the part of the student, as the book is designed to give only the necessary essentials, and so requires the student to do some thinking for himself. The principles of orthographic, isometric and oblique projection are all clearly but concisely explained and illustrated. The author probably has some reason for omitting the subject of gearing, which usually forms a part of most texts on drafting. Machine or free-hand sketching is given consideration, and the reviewer concurs with the author's opinion that this is of unequaled value to engineering students.

On the whole the book has unusual merit for the purpose for which it was written.

Descriptive Geometry. By H. W. Miller, M.E. Leather, 5¼ x 7¼; 128 pages; 149 figures. Peoria, Ill., Manual Arts Press, $1.50 net.

The subject matter of this book is divided into three parts. Part 1 takes up the problems of the point, line and plane; Part 2 covers lines and surfaces, tangent planes to curved surfaces, intersection of plane and curved surfaces, development of surfaces of cones and cylinders; Part 3 covers shades and shadows and perspective. There are eight sheets of quiz problems inserted at the end of the book.

The author has laid particular stress on the importance of the careful analysis of problems. The first principles are well explained and illustrated by pictorial representations.

Failure to insert problems throughout the text to be worked out by the student deserves especial criticism. There also seems to be no good reason for presenting the subject matter of descriptive geometry written in the first angle, since a very large percentage of the American drafting rooms use the third-angle projection in their drafting work.

Air Compression and Transmission. By Prof. H. J. Thorkelscn, Associate Professor of Steam and Gas Engineering, University of Wisconsin. Cloth, 6 x 9; 207 pages; 143 figures. New York, McGraw-Hill Book Company, $2 net.

Some idea of the extensive field embraced by the text of this book may be gathered by a survey of the subjects of the chapters, which are as follows: Characteristics of air, definitions, equations, diagrams, air at pressures below atmosphere, air at low pressures, piston compressors, efficiencies, multi-stage compression, details of piston air compressors, hydraulic compression of air, turbo-compressors, effect of altitude and compressor tests, receivers, selection and care of compressors, appendixes A, B and C.

An examination of the book clearly reveals the fact that, to be of service, it must be very largely supplemented by other material. To the student with no other recourse for assistance it is in places far beyond his comprehension, while in others it is too brief. For the engineer there is too much matter which is of no practical value, such, for instance, as the space taken up by illustrations of the simplest and most common forms of mechanism.

To cover properly the field indicated by the title either very much more space is required or else the book should be very radically rearranged.

The illustrations, while well executed, are in several instances not pertinent enough for insertion, and this detracts from the book.

Whatever formulæ are found may be discovered in nearly every treatise on thermodynamics; in most cases they cover other fields than those indicated by "Air Compression." It is to be regretted that the author did not take better advantage of the fact that there is hardly any book in exisence which properly treats of the field indicated.

In conclusion, it may be said that the book undoubtedly serves its purpose quite satisfactorily in the author's own classes, when it is in all probability supplemented by lectures, but taken by itself it is difficult to properly state its function.

The Catskill Water Supply of New York City. By Lazarus White, Assoc. M. Am. Soc. C. E., Division Engineer, Board of Water Supply. Cloth, 6 x 9; 755 pages; 239 illustrations. New York, John Wiley & Sons, Inc., $6 net.

When the Board of Water Supply of the City of New York was organized in 1905 to design and build the great aqueduct to deliver an additional water supply of 500,000,000 gal. daily from Catskill Mountain sources 100 miles distant from the City Hall the eyes of the engineering world were immediately focused on the project, for here was a work of stupendous proportions, calling for the country's best engineering brains, the expenditure of many millions of dollars, the solution of problems without precedent to follow and the development of special plant and methods of construction. The water-upply project involved the organization of a great engineering force and the building of huge dams of cyclopean masonry, concrete aqueduct with inside dimensions of 17 x 17½ ft., deep tunnels through bedrock hundreds of feet below the ground surface, and steel-pipe siphons lined with a thin protective sheet of concrete. It was to have been expected that a project of such magnitude would develop problems of design and construction of unusual interest, and that this expectation has been realized is at once apparent to the reader of Mr. White's book.

Mr. White has been connected with the Catskill aqueduct work practically from its inception and as division engineer in charge of location and construction on various parts of the line he has had unusual opportunity to gather data of great value. Often in the press of construction work engineers think only of the present and when the final estimate is made up there is no permanent record of what has been accomplished. In a few years even those intimately associated with the project retain but a hazy idea of the many interesting details of design and construction which other engineers would give much to know about. Mr. White, therefore, is to be congratulated upon the service he has rendered by presenting a comprehensive account of the Catskill work. His book has the peculiar merit of having been written in the very atmosphere of construction and with the inspiration of daily contact with directing engineers and contractors.

The book begins with a history of the water supply of New York from the days of the public pumps of the Dutch settlers down to the present. There follow chapters on the organization of the engineering and administrative bureaus of the Board of Water Supply, location studies for the aqueduct, borings and subsurface geological investigations, with special reference to the celebrated tunnel crossing, 1100 ft. below the Hudson River. Succeeding chapters deal with the preliminary studies, design, and the construction of every link in the 100-mile chain of dams, aqueducts, tunnels and pipe lines.

The author has covered his subject in great detail and the book gives every evidence of painstaking effort to present the complete story of the Catskill aqueduct. Although the greater part of the work is descriptive, much of it is devoted to discussion of design and plant layout, and there are valuable data on progress and costs, particularly in relation to diamond-drilling, tunneling and shaft-sinking.

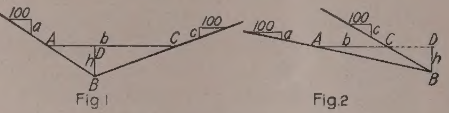
The book is illustrated with numerous reproductions of photographs and contract drawings, and the text is well subheaded, so that one may find any subject readily and concentrate upon the sections of particular interest.

No waterworks engineer can consider himself abreast of the times without a knowledge of what has been done on the Catskill aqueduct. For several years past it has been the Mecca of engineering pilgrims from all over the world. For these Mr. White's book will serve as a veritable engineering "Baedeker." Others, not so fortunate as to see the great work in progress, can still gain a vivid impression of it from the printed page, for Mr. White takes his reader by the hand, as it were, starts in at the upper end of the aqueduct, at the Ashoken reservoir, and traverses every foot of the line, pointing out the interesting features, giving reasons for this and that, and explaining just how every detail of the great work was carried out.

Letters to the Editor

To Find the Point of Intersection of Two Grades

Dear Sir: To find the stationing and elevation of the point of intersection of two grades a convenient method is first to fix a point on the one grade of the same elevation as a known point on the other, and then solve with the formulæ derived below. In each of the figures a and c are the arithmetical grade percentages, b is the horizonal distance between the two points of equal elevation A and C, and h is the difference between their elevation and that of the point of intersection B.



Two Typical Cases

For Fig. 1, where the grades slope in opposite directions,

$$AD + DC = b$$

or

$$DC = b - AD$$

$$AD \times a = DC \times c$$

Substituting

$$AD \times a = (b - AD)c = cb - AD \times c$$

or

$$AD = \frac{cb}{a + c}$$

$$CD = \frac{ab}{a + c}$$

and

$$h = \frac{acb}{100\,(a + c)}$$

In the case of Fig. 2 the first equation above becomes $AD - DC = b$, and the resultant equations are

$$AD = \frac{cb}{c - a}, CD = \frac{ab}{c - a} \text{ and } h = \frac{acb}{100\,(c - a)}.$$

Tacoma, Wash. Erwin Davis.

Variation in Level of Great Salt Lake

Dear Sir: Reference is made in this letter to the article with the above title in the Engineering Record of June 28.

To begin with, the diagram of fluctuations is in error. The records show that the lowest stage recorded since records have been kept was reached in November, 1905, following a fairly regular fall since 1900, whereas the diagram shows a decided rise and subsequent fall between 1903 and 1906.

The assumption that the record of the rise and fall of Great Salt Lake in common with other similar bodies in the arid West is of great value is true, as is the sentence reading, "When we consider the fact that most large investments," etc. The facts known to all who have had to deal with the problem, however, are so at variance with the remainder of the article that I am writing this letter by way of explanation.

It is stated in the first paragraph of the third column that "the conclusion might then have been drawn that with the development of irrigation, aided, perhaps, by certain progressive climatic changes, the water supply to Great Salt Lake was practically cut off."

This assumption was popular with laymen, and the second part thereof properly, as I am ready to show. The first part of the assumption relative to irrigation, however, was never accepted by engineers.

It is a fact, easily deduced, that the remarkable fall of the lake from 1900 to 1905 was directly due to the general lack of precipitation over the Great Salt Lake watershed, and, vice versa, the remarkable rise from 1905 to 1910 was due to the great excess of precipitation.

Great Salt Lake is fed largely by the Bear, Weber and Jordan Rivers. During the period 1900 to 1905 there were no irrigation developments that in the slightest measurable way could have affected the fluctuations of Great Salt Lake. For many years the normal summer flow of all the streams discharging into the lake has practically been used up, and there have been no storage developments that have interfered with the surplus flow. The early spring and summer flows govern the rise of the lake. This is readily seen from the average monthly discharges of the Bear River for the period beginning with 1890 and ending with 1910, in thousands of acre-feet:

Jan.	Feb.	Mar.	Apr.	May	June
95.12	83.30	143.34	225.31	299.58	262.99
July	**Aug.**	**Sept.**	**Oct.**	**Nov.**	**Dec.**
112.99	57.43	59.12	80.97	84.00	83.73

The average discharge of the Bear River during the period 1900 to 1905 was 1,054,500 acre-ft., against a normal discharge of 1,583,180 acre-ft. For the period 1905 to 1910 the average discharge was 1,936,000 acre-ft. as against the same normal discharge, showing a deficiency for the first period of over 500,000 acre-ft. per annum and for the second period an excess of more than 350,000.

The precipitation at Salt Lake City for the periods last mentioned was as follows: 1900 to 1905 inclusive, average 14.03, normal 16.03; for 1906 to 1910 inclusive, average 19.68, normal 16.03. The precipitation for the entire Great Salt Lake drainage basin follows this closely as to excess or deficiency.

I have not had the time to go into the matter in detail, but I think the above is sufficient ground, together with the first-hand knowledge that there have been no reservoir projects which have affected the flow of the streams discharging into Great Salt Lake, to say positively that it was the lack of precipitation that caused the fall and an excess of precipitation that caused the rise from 1900 to 1910.

In conclusion I might add that the statement that the reservoirs in the West are at the lowest stage ever known does not apply to Utah.

H. S. Kleinschmidt,
of Brown & Kleinschmidt,
Salt Lake City. Consulting Engineers.

Utility vs. Beauty

Dear Sir: Apparently the writer of the paragraph on the proposed New York court house, which appears in your editorial columns of July 5, is not familiar with the plans prepared by Mr. Guy Lowell.

A short study of the drawings would convince him without a doubt that the arrangement of rooms is such that the utmost convenience has been attained, that the building will be lighted and ventilated much in excess of that designated by good standard practice, that the expense of construction is far less than would be the case in a building of rectangular or other form, inasmuch as the unused space is a minimum, and finally that the problem of future extension has been amply provided for.

Probably one of the best features of Mr. Lowell's plan is the fact that ideal circulation has been obtained. A person, having arrived in a wrong court room, may reach the proper one in a very short time and with very little walking. Privacy for the justices is a very noticeable point of interest.

So the proposed circular court house is not a case of "Utility vs. Beauty," but is utility combined with beauty.

Albion N. Van Vleck,
Structural Engineer
[in office of Guy Lowell].

New York.